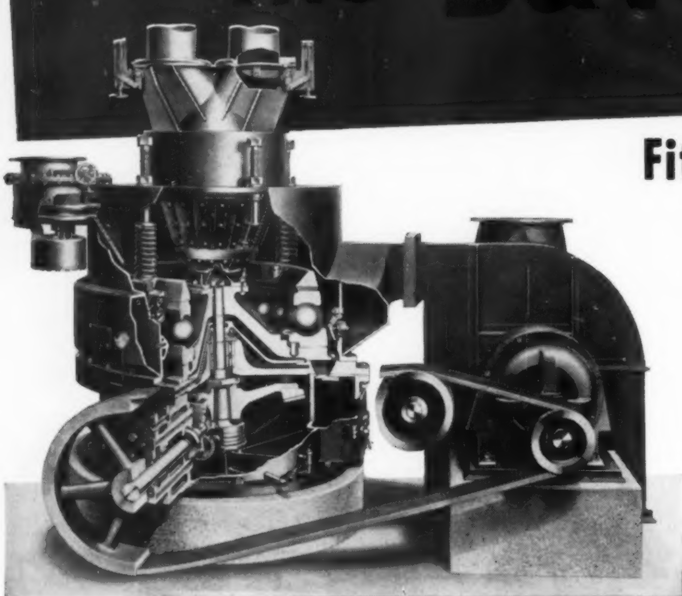
MECHANICAL ENGINEERING

FEBRUARY 1944

The B&W Type E Pulverizer



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Operates reliably and effectively in direct-firing pulverized-coal systems

By every standard of direct-firing pulverizer performance, the Type E Pulverizer fits into the fuel economy picture any day, and especially so during the present emergency requirements.

Type E Pulverizers—

Are reliable in service and low in maintenance, as measured in service hours before replacement of parts becomes necessary.

Respond readily to load changes—output controlled at one point, the primary air damper, and are adaptable to fully automatic control.

Maintain fineness and capacity throughout life of grinding elements.

Handle coal of a wide variety and, due to drying in the mill, can handle coal with as much surface moisture as it will carry.

These and other features of the Type E Pulverizer are given in more detail in Bulletin G-30-A. Copies obtainable on request.

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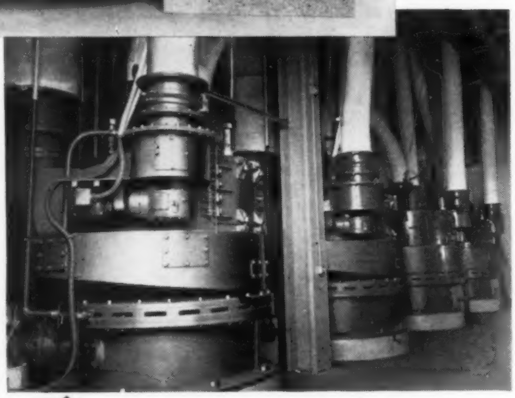
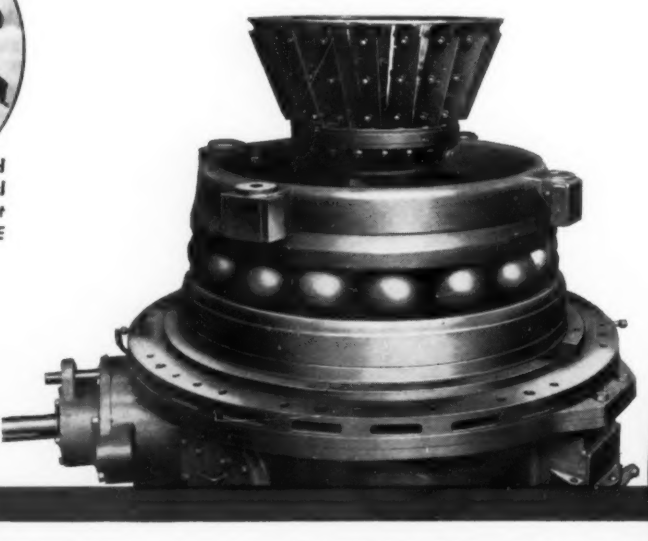
Type E Pulverizer with pulverizing elements and fines classifying elements in upper section and driving elements in lower section sealed and protected from coal dust. Primary air fan, which handles clean air only, is generally driven by same motor that drives the pulverizer.



Over 400 Type E Pulverizers are in service or on order for direct firing boilers. Individual installations have as many as 16 units.

The Army-Navy "E" and Maritime Commission Award flags are floated proudly at the plant that builds Type E Pulverizers.



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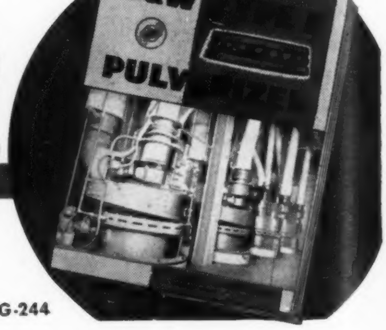

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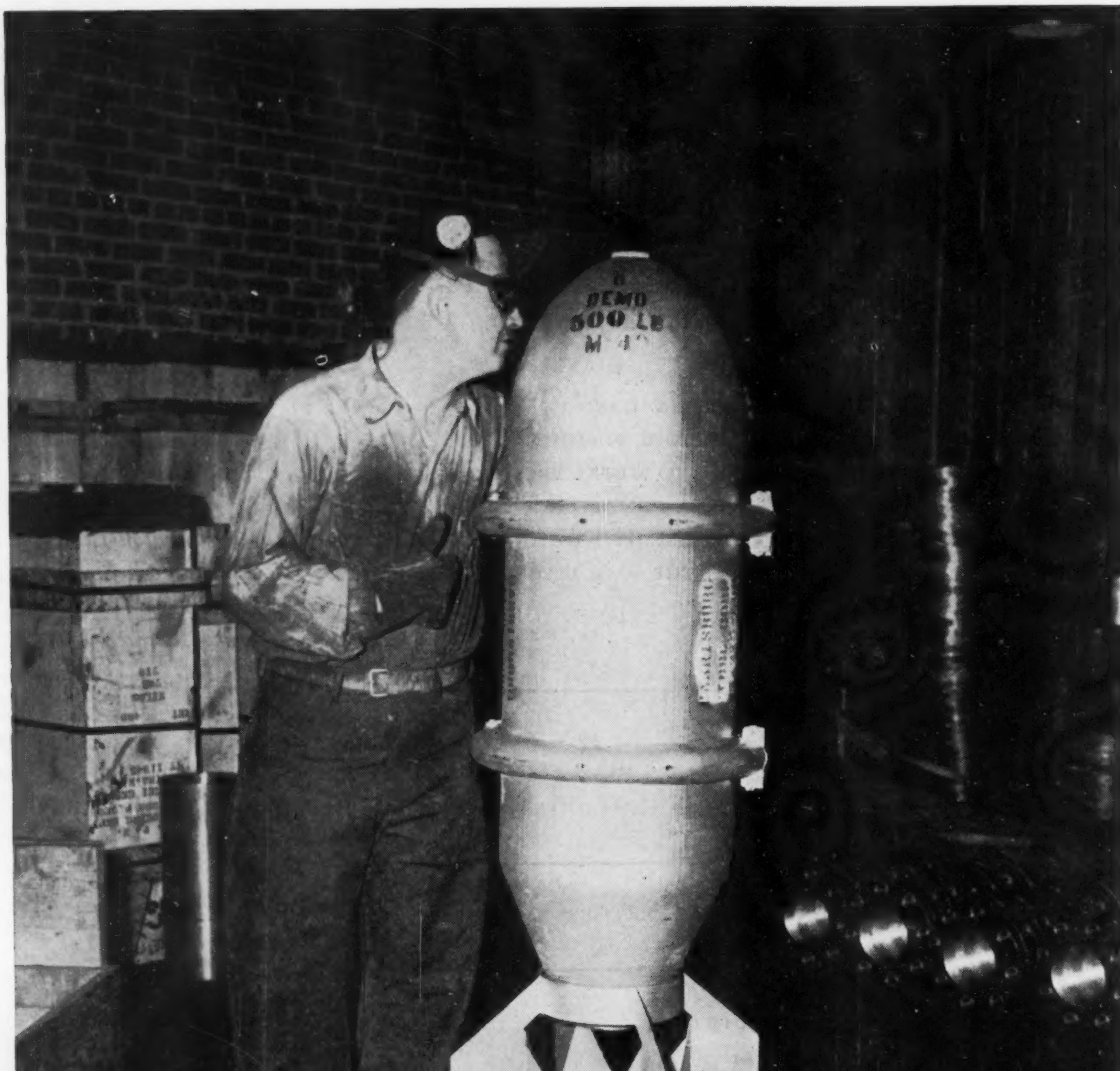


U. S. Army Signal Corps Photo

Five-Hundred Pound Demolition Bomb

(Ready for shipment to an Ordnance Department loading plant to be filled with high explosive, this bomb is getting final examination. Fins were attached for photographic purposes. Bands around the bomb are to facilitate handling. Bomb fins are attached at airfields since bending of a fin in handling or transit would affect its accuracy in descent.)

VOLUME 66
No. 2

MECHANICAL ENGINEERING

FEBRUARY
1944

GEORGE A. STETSON, *Editor*

You Can Help

ABOUT the time this issue is in the hands of readers, members of The American Society of Mechanical Engineers will receive a letter from President Gates asking them to co-operate with the Society in another program of paper conservation. This letter, which is being sent to all members whose names are on the mailing lists of Transactions and the *Journal of Applied Mechanics*, asks permission to remove names from the mailing lists of these two publications provided, for any reason, the member can get along without one or both of them. A similar letter, signed by President Parker and sent out two years ago, resulted in a generous response which, on a yearly basis, saved paper at the rate of about 11 tons.

Certain points in the plan should be emphasized to avoid misunderstanding. In the first place, no one who uses the Transactions or the *Journal of Applied Mechanics* should feel under obligation to give them up. Any member who does give them up may ask to have his name restored to the mailing lists whenever he feels he has need of them. The object is to save paper and not to deprive members of needed services.

A further point to be made clear is that there will be no rebate in dues to members whose names are taken from the mailing lists at their own request. The saving per member is almost negligible because a major portion of the total publication expense is incurred before a single copy is printed. Few members who permitted removal of their names from the mailing lists as a result of President Parker's letter raised the question of a rebate of dues. It is generally recognized that the request is a wartime measure which aims to save paper in the national interest without interrupting the publication of technical information by the Society.

Finally it must be emphasized that Mr. Gates's letter does not involve MECHANICAL ENGINEERING.

A.S.M.E. Is Doing Its Job

COMMENTS on the 1943 A.S.M.E. Annual Meeting have been enthusiastic and interspersed with deserved commendation. The "size" of the meeting, which broke all previous records, has been the feature which has most generally impressed members in attendance. It has also been the subject of discussion by those responsible for the program and its operation. Was the meeting too big and, if so, what can be done about it?

Opinions differ widely on the value of a "big" meeting. With most of us it is human nature to be impressed with size. If we get into a crowded hall we are more likely to feel that we have been fortunate in gaining admission than we are to wish we had stayed away because of crowded conditions. There is something infectious about a crowd of persons all wishing to do the same thing that confirms each person's judgment in having decided to make himself one of them. Most speakers do better with a large audience than before a handful of persons, regardless of how important his subject is or how worthy his listeners may be. Large audiences and a crowded meeting are more likely to reward those in responsible charge than would a small attendance of experts. Up to the limits of discomfort on the part of the audience a large meeting pleases those who attend, those who contribute, and those who plan and operate.

There is another aspect to the size of a meeting on which opinions differ. A meeting can be large because thousands of persons crowd into a large auditorium to listen to one or a few speakers on a single subject. It can also be large because the same number of persons distribute themselves over half a dozen meeting halls to listen to that many more speakers on that many more topics. It is this second type of meeting that makes A.S.M.E. affairs large—diversity of subject matter offered in simultaneous sessions.

It is not hard to understand why A.S.M.E. meetings run to many simultaneous sessions. Its work and its organization cover innumerable fields, all more or less related under the general banner of mechanical engineering. Professional divisions and technical committees are organized under the A.S.M.E. to care for the interests of members working in various sectors of the field of mechanical engineering. What a division or a committee has to offer the individual engineer in the sessions it sponsors may be worth more to him than everything else in the entire program put together. Although there are no statistics to prove it, it could probably be demonstrated that a majority of decisions to attend an A.S.M.E. meeting are based on a desire to take part in a specific part of the program.

Not all engineers attend Society meetings because they wish to listen to the discussion of a single subject or group of subjects. There is always a chance, they argue, that they may pick up something of interest in another field that can be applied in their own. People do not travel to see familiar sights but to discover new ones. Diversity itself becomes a virtue in the multiple-session meetings of A.S.M.E.

A large Annual Meeting poses a number of questions difficult to answer and obligations on the Society difficult or irksome to discharge. It implies, for example, a large and diversified volume of published material. Here again many of the arguments in favor of large and diversified meetings apply. Papers of special interest to persons working in a given field are assessed at values out of all proportion to the number of actual readers. And

the inquiring person who is always wondering what the other fellow is doing that he can apply in his own work may get more from a dozen papers in as many different fields than from reading about what is going on in his own field of interest. As a feeder for publications a large Annual Meeting offers variety and opportunity for selection of the best.

There is one other point about large meetings that should be mentioned. They are not the result of an attempt to increase volume and diversity over all previous records. They are the result of the pressure of persons and committees and divisions who have papers to present and audiences to be satisfied. What better indication can there be that the Society is strong, alive, engaged in useful work, and attempting to satisfy the demands of its members? What better indication can there be that its members are hard at work and eager to increase their knowledge so as to be able to do a better job? Are they not indications that the Society has worth-while objectives and is attempting to attain them? From such rich resources the best can be gleaned to improve quality. While such conditions exist the A.S.M.E. is doing its job.

New Preprint Procedure

FOR the next two A.S.M.E. meetings, one in Birmingham in April and the other in Pittsburgh in June, The American Society of Mechanical Engineers will try out a new preprint scheme. Heretofore, papers presented at Society meetings, if they have been received on time and have passed the requirements of the sponsoring groups and the Committee on Publications, have been put in type for ultimate publication in Transactions, *Journal of Applied Mechanics*, and MECHANICAL ENGINEERING and have been preprinted for discussion at the meeting. For the next two meetings photolithographic copies of the author's typescript will be made to supply preprints.

In undertaking this experiment the Society is placing all authors on warning that typescripts of papers must be prepared more carefully than in the past, not only for the benefit of readers but also to save their own faces. A photolithographic reproduction of a typescript faithfully copies every mark on the original typescript. Editing to correct even obvious errors, careless typing, and badly prepared copy for illustrations is not practicable with photolithographic printing unless all papers are retyped by the Society, an expense in time and money that cannot be justified. With the new scheme every author will have the satisfaction, or suffer the embarrassment, of exhibiting to the public just how carefully, or carelessly, he can prepare the typescript and illustrations of his paper.

The Committee on Publications expects that the experiment will be a revealing experience not only to itself but to authors and Society members as well. It also expects to gain certain advantages to offset the few disadvantages of the new means of preparing preprints. The disadvantages will be obvious to everyone. How serious they will be will depend to a large degree on the co-operation of authors.

The advantages of the new plan are not so obvious. Particularly during the war years, preprints in the familiar form have been difficult to prepare owing to lack of time. Under present conditions developments move so rapidly that many papers are not prepared long enough in advance to allow time for editing, typesetting, proofreading, and printing. With the new scheme all of these steps except printing are eliminated. Hence a larger proportion of papers received late can be put in preprint form. This is a decided advantage to members who wish to discuss papers at meetings and those who wish to get copies of papers at the earliest possible moment.

Another advantage that the new scheme should afford is a possible improvement in the general quality of the Society publications. Under the plan followed up to now, decision to publish a paper received in advance of the meeting must be made under difficult conditions. Neither the committees and divisions which solicit papers for meetings and recommend them for presentation and publication nor the Committee on Publications which authorizes publications has an opportunity to see all of the papers contributed at a meeting at one time and place. With a limited publication budget not every paper presented at a meeting can be published. Obviously, it is the desire of all concerned that the best papers be published. Under the new scheme the relative merits of the entire group of papers can be more accurately assessed. The result should be an increase in the quality and value of the Society's publications.

Nor is this all. Under the former scheme time did not always permit the most careful preparation of papers for publication. Before every meeting there is always a period when papers are received in such volume and so late that desirable revisions can be made only at the risk of failing to provide a preprint. A majority of papers could be condensed, with a saving of publication expense and an improvement in readability without loss of essential material, if time permitted rewriting. Without the pressure of meeting a dead line in preparing a preprint in form for final publication, opportunity to condense and clarify papers before they appear in the Society's publications will be afforded. This too should operate to improve the quality of Society publications.

Although the photolithographing of authors' manuscripts to provide preprints of Society meeting papers will be the general rule, exceptions may be made in certain cases. It is possible that some papers which have no illustrations, mathematics, or involved tables can be mimeographed more cheaply and satisfactorily than they can be photolithographed. There will be no departure from the Society's policy of publishing some papers in MECHANICAL ENGINEERING in advance of the meeting. Preprints of papers for the *Journal of Applied Mechanics*, will probably be handled in the future as at present.

In summary, therefore, the purpose of the proposed preprint scheme is to provide more preprints of Society meeting papers, in general photolithographed directly from the author's typescript, and to improve the quality of the Society's publications. Time alone will tell whether or not the new scheme will fulfill the expectations of the Committee on Publications. Much depends on the co-operation of the authors in preparing copy for photolithographing and in revising and condensing their papers, if requested to do so, before publication. Instructions for the preparation of copy for photolithographing are available.

U. S. Army Air Forces Photo

AIRPORT AT MARIENBURG, GERMANY

(The Focke-Wulf 190 Plant at Marienburg, one of the Nazi's largest assembly plants of fighter aircraft, before Army planes released their bombs.)

WINNING BATTLES *by* BOMBING

By LT. COL. NATHANIEL F. SILSBEE

INTELLIGENCE DIVISION, AIR STAFF

BATTLES are won by bombing long before the battles take place. Here is the paradox of strategic air power, which has already gone far in the process of revolutionizing warfare. Hitherto war has been two-dimensional, and victory has gone to the side which can defeat the enemy armed forces in the field and destroy or blockade his naval forces. Through air power war has become three-dimensional, and great fleets of bombers soar over enemy-controlled oceans or land, striking at the vital war industries which support the armies and navies. Bombing wins battles by destroying at the source the stuff with which battles are fought.

Take the North Africa campaign. Long before the break-through at El Alamein bombers of our Ninth Air Force and the R.A.F. Middle East were smashing Axis docks and shipping at Tobruk and Bengasi, and ports in Crete and Greece. By sinking a large percentage of the ships laden with supplies for the Afrika Korps, especially tankers carrying gas and oil, Rommel's heavy supply line was dried up.

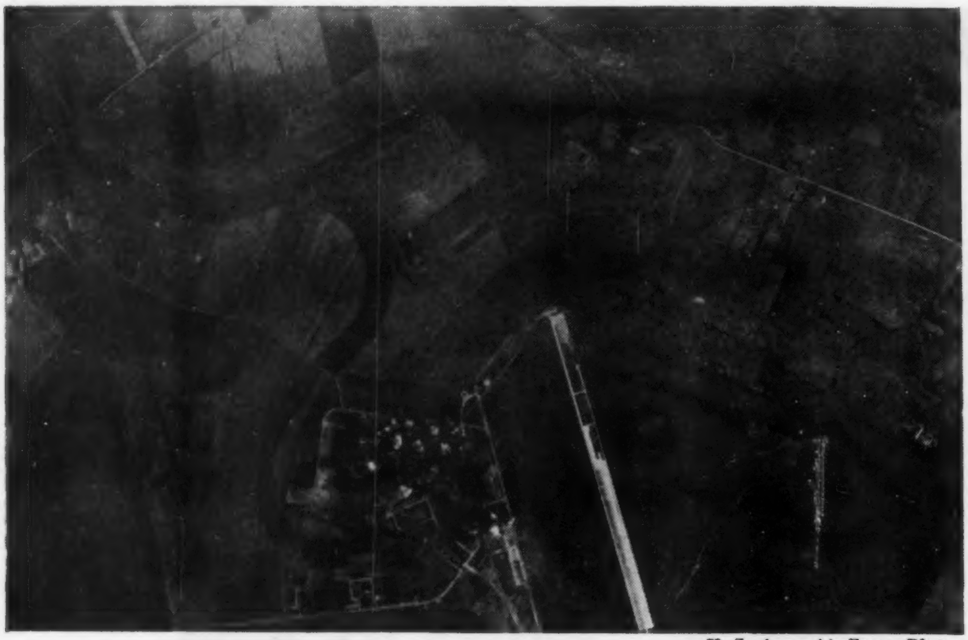
Many months before the Battle of Tunisia bombing was striking blows, the full effect of which was not seen until the Axis forces suddenly collapsed like a house of cards last May—such blows as knocking out several months' production of the Renault truck and tank factory, Paris; the Matford motor-transport factory at Poissy; complete destruction of a machine-tool factory at Düsseldorf, causing long delay in the production of heavy antiaircraft guns. Not only was production slowed down, but the flow of supplies and equipment to the fighting front was further reduced by smashing up railroad yards, blasting bridges, blowing up locomotives and freight trains. That strategic bombing of German war industry has had an important effect on the fighting in Russia has been officially admitted in Moscow.

DESTRUCTION OF GERMAN WAR PLANTS

Before bombers can knock out these vital targets a certain measure of air mastery over the enemy territory must be attained. The first step, therefore, in the strategic bombing offensive is the destruction of the enemy's fighter strength. In the air campaign against Germany the destruction of the Luftwaffe occupies an important place in the assignment given to the U. S. Army Eighth Air Force. The other main objective is the destruction by precision bombing of the key factories of key Nazi war industries. The R.A.F. Bomber Command's assignment emphasizes the destruction of the industrial portions of a certain number of key cities in overwhelming attacks by night, with its consequent effect on worker and general civilian morale. British authorities estimate that out of a total of some 50 key cities, about 15 have been knocked out as industrial factors in the war. Cologne and Hamburg were so heavily damaged that they have practically ceased to exist as organized cities. The recent devastating attacks on Berlin indicate that this highly important war capital and industrial city is in the process of meeting a similar fate.

Enemy fighter strength can be destroyed by hitting the fighters on the ground, by forcing them into the air and destroying them in combat, by knocking out the factories producing finished fighter planes or parts and subassemblies, and finally by destroying the centers where fighters are stored, serviced, and repaired. For several months the Eighth Air Force has been systematically doing all these things as an indispensable prelude, not only to an invasion of the continent, but to an all-out

An address delivered at the Aviation Luncheon at the 1943 Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, of The American Society of Mechanical Engineers. (Revised)



U. S. Army Air Forces Photo

THE FIRST BOMBS HAVE JUST HIT

(Note how perfectly they are being concentrated within the comparatively small area of the target.)

air offensive which could conceivably go far toward knocking Germany out of the war before the invasion gets under way. This element of over-all strategy was finally accepted at Casablanca and is part of what Prime Minister Churchill had in mind in his frequently quoted statement, "We do not know whether Germany can be knocked out of the war by air power alone, but there's no harm in finding out."

HOW AIRCRAFT PLANTS HAVE BEEN DAMAGED

Since early 1943, after the Nazis realized that American daylight bombing missions, if unhindered, could become decisive, the German aircraft industry began a sharp swing toward fighters, including the single-seat day fighters, the Messerschmitt 109G and Focke-Wulf 190, day and night fighter versions of the versatile JU-88 twin-engine bomber, and the new speedy twin-engine fighter-bomber ME-410. It should be more widely realized that this is an unusually formidable array of fighter opposition. It has become apparent that although in this swing away from bomber production the Luftwaffe's power to strike offensively in force has been reduced, there is an almost frenzied determination to stop our bomber attacks at any cost. Destruction of the fighter factories thus became a top priority effort of the Eighth Air Force as soon as its seriously depleted strength (largely due to allocation of many of its heavy bombers to the North Africa campaign) was built up.

The first heavy blow was on April 17, when a comparatively large force of Fortresses smashed the big Focke-Wulf factory in Bremen, where some 35 per cent of the FW-190's were produced and a considerable proportion of the FW-189 twin-tailed reconnaissance planes. In the heavy attacks by the R.A.F. Bomber Command on Bremen this factory had somehow been missed. The Eighth caused such severe damage that reconnaissance photos weeks later showed very little attempt to restore the plant, and reliable reports indicate that the activities were removed far to the east in Marienburg.

The last week of July was by far the busiest the Eighth had had to date. After successful attacks on important aluminum and magnesium factories in Norway on July 24, the big shipyards at Kiel on the 25th, a huge tire factory at Hanover on the 26th, a daylight blow at Hamburg on the 27th (to speed up the R.A.F.'s devastating campaign on that key city), the main U.S.A.A.F. drive on the single-engine-fighter plants got under way.

First on the list was the Ago-Flugzeugwerke at Oschersleben on July 28. This plant turned out about 60 FW-190's per month, and despite heavy clouds over the target considerable damage was done. A diversionary attack on the same day was carried out against the Fieseler Flugzeugbau Bettenhausen plant near Kassel, which turned out component parts for FW-190 production at their larger Waldau assembly plant, also near Kassel. This latter factory received attention on July 30 and some damage was inflicted, curtailing production of about 30 FW- 190's per month. Incidentally, Kassel itself was wiped off the industrial map by the R.A.F.'s crushing blows on the nights of October 3-4 and 25-26, with a total of over 3000 tons of bombs.

Going back to the Eighth Air Force nonstop program of July 24–August 1, what was the matter with July 29? Believe it or not, they were in there pitching that day too, this time visiting the Arado Flugzeugwerke at Tutow, near Warnemunde, where some 60 FW-190's per month were produced. Damage was so serious that photographs in August and again in September indicate very little activity, the latest report being that the factory may be abandoned.

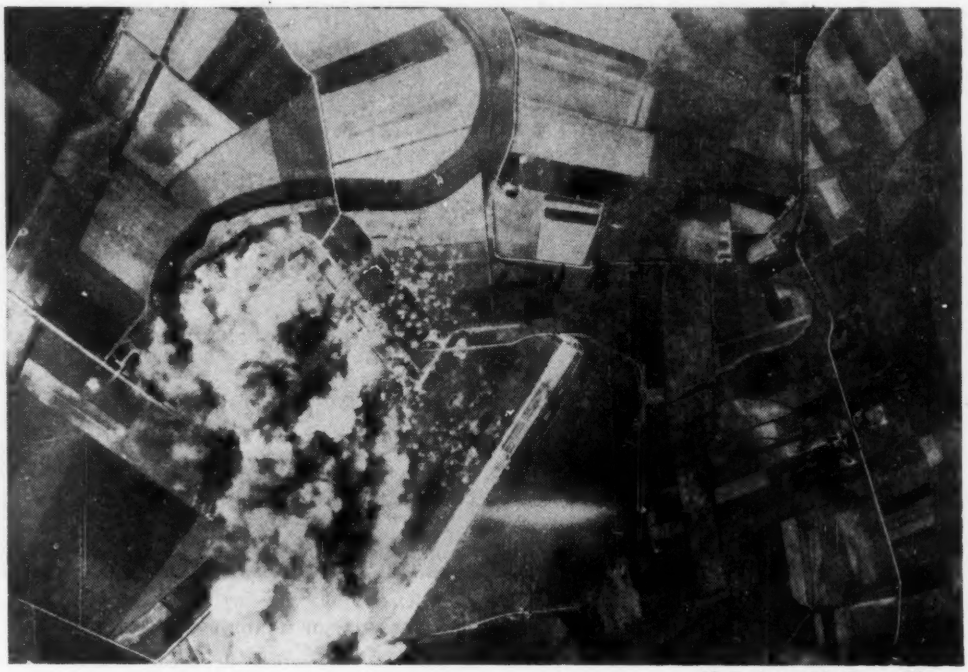
This series of attacks in late July slowed down or temporarily discontinued monthly production of about 150 FW-190's, the big factory in Marienburg, East Prussia, accounting for 100 to 110 more per month. Oddly enough this factory was organized in the early autumn of 1942, a few weeks after the successful demonstration by our Eighth Air Force that our big day bombers could get through to their targets and back, knocking out impressive numbers of the best current Luftwaffe fighters, and inflicting heavy damage by precision blows at key targets. When the huge Bremen plant was practically destroyed last April, the FW-190 program was shifted to Marienburg, making that a high-priority target.

On the 1800-mile round tripper of October 9 this plant was one of the principal targets, and the results were so good that General Arnold has described it as probably the most successful precision attack of the war to date. R.A.F. Air Chief Marshal Sir Charles Portal regarded it as the most nearly perfect example in history of the accurate distribution of bombs over a target. Every building of the Marienburg plant was damaged, many utterly destroyed. It will be out of production for many months and may have to be abandoned entirely. To rebuild it there or anywhere else, with all that means in the way of machine tools, fixtures, and jigs, will be a tough job. It will be almost as bad to try to convert some already existing factory in East Prussia or Poland to carry on the lost FW-190 production. Long before they can get that rolling our heavy bomber bases in southern Italy will be operational. Our Fifteenth Air Force (Strategic), equipped with the latest models of heavily armed Fortresses and Liberators, protected by swarms of long-range Lightning fighters, has been set up for this very purpose of destroying some of the vital targets in the east which were so far from bases in England that too much of the load had to be

devoted to gasoline and too little to bombs.

A further blow to FW-190 production was struck on the same long-range mission of October 9 when heavy damage was inflicted on the Focke-Wulf component-parts factory at Anklam, Pomerania, some 90 miles north of Berlin. As a result of this series of attacks on factories turning out FW-190's of last July and early October, the output of this important fighter for the quarter ended October 31 was sharply reduced.

A similar program has been under way to knock out production of Germany's other standard single-engine fighter, the Messerschmitt 109. The newest model of this seven-year-old fighter is the fast and formidable ME-109G, with several subseries, equipped with the powerful Daimler-Benz 603 engine, which is rated at 1700 hp for take-off and 1500 hp for normal operation. The basic design of this engine, the Mercedes Benz 600, was under development nearly ten years ago, with a power output of 550–600 hp.



U. S. Army Air Forces Photo

BOMB BURSTS AND FIRE

(Create enormous cloud of smoke rising high into the air.)

The ME-109 production was concentrated in Regensburg, Wiener Neustadt, and Leipzig, all being a considerable distance from bases in England. You are familiar with the story of the Regensburg raid on August 17, when, as a part of their first-anniversary celebration of their initial daylight raid, the Eighth Air Force sent out some 150 Fortresses against the Messerschmitt factory, dropping about 300 tons of bombs and destroying an estimated 60 per cent of the works. Peak monthly capacity may have been around 250, current production being 200 per month according to Major General Fred Anderson, bomber chief of the Eighth Air Force. Photos taken a month later showed that repairs had been started. Two months later it it appeared that the machine shops and subassembly shops were in fair shape on the outside at least, and that three new buildings had been started. However, it is safe to say that at least 500 ME-109's in production have been denied the Luftwaffe on account of the Regensburg mission. Who can estimate how many score of our heavy bombers have been getting in their destructive blows and returning safely to base because of this one attack in mid-August? This is winning air battles by bombing and paving the way for winning the final battles when the big push starts.

Still further from England is Wiener Neustadt in Austria where between 200 and 250 ME-109's are produced each month, or shall we say were produced, at the Wiener Neustadter Flugzeugwerke. This important plant has been attacked three times from our bases in Africa, by our Ninth Air Force on August 13 and October 1, and by the Fifteenth on November 2. The latter attack, using large formations of Fortresses and Liberators, was highly destructive, the main assembly plant being demolished.

The third important ME-109 factory is the Erla-Maschinenwerke at Leipzig, with a production of about 150 per month. On October 20 the R.A.F. gave this important industrial and transportation center near the Czech border its first large-scale blasting of the war, and on account of the distance, the first at all for nearly three years. It is not certain how much damage was inflicted on the Erla plant, but with two out of the three ME-109 factories out of the running for many weeks, plus the need to send some fighter strength to the south to meet the growing threat from Italian bases, the increased strain on the Luftwaffe is evident. On December 6 a still heavier attack by the R.A.F. was made on Leipzig, after a feint at Berlin; and subsequent photographs show extremely heavy damage.

ENGINE PLANTS TO BE DESTROYED

There are also a number of aircraft and engine-service depots in occupied France, many of them on the "warning list" sent out by the Eighth Air Force a couple of weeks ago. New production facilities may emerge as a result of bombings already referred to, and some of the original plants may have to be revisited as that all-important ally, aerial photographic reconnaissance, shows renewed activity. But by and large this part of the program appears to have achieved substantial success to date.

A fairly recent and altogether formidable threat has come into the air defense picture in addition to the fast, maneuverable, hard-hitting single-seater fighters. These are the larger twin-engine fighters and fighter-bombers, especially the JU-88 and the new ME-410, with some of the older ME-110's still encountered. These planes have been holding off out of range of the 0.50-caliber guns of our heavy bombers and firing explosive shells into our tight formations and also using rocket guns and powerful 30-mm cannon. They get in their deadliest work on the long-range missions after our fighter escort has turned back. The obvious answer to that one is already well on the way up—extra-long-range drop tanks for our Thunderbolts and Lightnings to enable them to go all the way and take care of these "bandits" before they can get to our bombers.

However, it will also help to knock out a few of the factories where these types are being turned out. The same goes for plants turning out BMW-801 radial and Daimler-Benz and Jumo liquid-cooled engines, which power practically all of the Luftwaffe's combat planes. Already one important propeller factory, the Heddernheim V.D.M. Propeller Works, Frankfurt, largest single unit in the industry, has been severely damaged in the Eighth Air Force Mission of October 4 All this unfinished business will indicate the difficult and complex nature

U. S. Army Air Forces Photo

RECONNAISSANCE VIEW OF MARIENBURG, GERMANY

(This view taken soon after the attack reveals that the plant has been entirely devasted. Assembly shops, hangers, and more than a score of smaller structures have been destroyed.)

of the problem of clearing the Luftwaffe from the skies over Europe.

SERVICE FACILITIES CRIPPLED

One feature of this campaign has received little public attention. No air force is better than its service facilities. This was a weakness even in the palmy days of the Luftwaffe when it was rolling everything before it in concentrated strength on a single front. It was very noticeable when the German Air Force failed Rommel in his drive toward Egypt. This defect has now been more than remedied, however, and to keep the large number of fighters ready for service on the western front, an excellent system of facilities has been in operation in France, Belgium, and Holland.

Those in the Paris area include the Hispano Suiza Aero Engine Works (repairs Daimler-Benz engines); the Gnome et Rhone factory at Le Mans airdrome (repairs DB engines for JU-88's, etc.); the Renault Avions Caudron works (repairs ME-109's); and the Villacoublay aircraft repair depot (FW-109's and JU-88's), one of the largest on the western front. Nearest of all to the main fighter bases is the large Potez aircraft repair and storage plant, Meaulte (near Albert); another storage depot for reserve fighter aircraft (single and twin-engine types) is at Romilly; still another is at the famous Le Bourget airfield, Paris. The function of these storage depots is to fill up the ranks of Luftwaffe fighter squadrons at the earliest possible moment after some of our successful missions in which 100, 125, or even 150 or more fighters have been destroyed or damaged. Probably the most important of all for single-engine fighters is the Erla Machinwerke Aero Engine plant at Antwerp, the factory which used to build the Minerva motorcars. In the big Antwerp attack on April 5 the buildings which serviced ME-109's were practically destroyed, but those repairing DB engines got off more easily. For servicing fighters and engines in northern Germany, Norway, and on the northern Russia front a combined service depot was set up near Oslo, Norway. A few days ago, this too was badly smashed up by a formation of Fortresses.

INCREASE IN GERMAN FIGHTERS LOST

The sharp increase in German fighters lost in combat since July is another significant trend. In north Europe alone the October figure was announced as 861 plus a large number of probables and damaged aircraft. Of these our heavy bombers knocked out roughly 90 per cent. The escorting Thunderbolts and Lightnings had an excellent record for the month in keeping the over-all loss ratio per number of sorties within the average for June, July, and August, despite the heavy losses on the Schweinfurt mission, most of which were inflicted beyond the scope of fighter escort. They also had a ratio of enemy planes shot down of better than 7 to 1 for the month.

November was the biggest month to date for the Eighth Air Force, with 11 missions, number of sorties 50 per cent above October, and tonnage of bombs up 40 per cent. December's record was still more impressive, with 10 missions, during which nearly twice the November tonnage was dropped on enemy objectives, and more than during the first six months of 1943. A feature of many of the recent missions was the use of new techniques enabling the bombs to be dropped through the clouds.

In addition to this direct counter air force activity, the Eighth Air Force has made many a contribution to victory in the battles that lie ahead in the successful bombing of such vital targets as the Schweinfurt ball-bearing works; the Huls synthetic-rubber factory; aluminum, magnesium, molybdenum, and electrical plants in Norway; and several devastating blows on strategic communications centers. Heavy strikes from North Africa, such as the Ploesti oil refineries, ball-bearing works at Turin, and aircraft factories at Wiener-Neustadt and Augsburg, have been effective and will be greatly extended when the air bases in Italy are prepared for our heavy bomber operations. The air circle around the Reich is getting tighter and smaller.

That all this must be followed by an actual invasion of the continent, in one or more places, is everywhere taken for granted. The notable work of the fast, powerful Marauder attack bombers based in England in systematically smashing up the Luftwaffe fighter bases across the channel is achieving a double purpose. It is keeping down our present strategic-bomber losses and also has an effect on activities of a later stage of development. It is entirely possible that strategic air power may be able so to wreck the German war potential and destroy the people's will to fight, that the invasion, when it comes, may prove to be more like an occupation. In any case, the reduced cost in lives and in time will be a priceless gain. This is the real objective of our present all-out air effort.

CRITICAL TRANSITION PERIOD *After* V DAY

By JOHN F. FENNELLY

EXECUTIVE DIRECTOR, COMMITTEE FOR ECONOMIC DEVELOPMENT, WASHINGTON, D. C.

THE title may suggest that the author considers possible a termination of all hostilities at one given moment, similar to the "cease firing" order which occurred at 11 a.m. on November 11, 1918. Such is not the case. At present all the indications point to a termination of the war in Europe at a date considerably earlier than the war in Asia.

As a result, many of our statesmen and business leaders have become fairly complacent on the assumption that we shall have a fairly easy period of transition between the defeat of Germany and the final crushing of Japan. This is a highly dangerous fallacy. It is estimated that, after the end of the European war, we may be forced to cut back our munitions production by approximately 80 per cent and still have enough to fight a full-scale war against Japan. Our stock of finished munitions will be so vast that some experts even speak of our ability to fight a long war against Japan out of accumulated inventories. This may prove to be somewhat exaggerated, but it serves to emphasize the fact that the major shock to our economy will come immediately after the end of the fighting in Europe, and not at some later date after Japan has been crushed. Hence we must make our plans accordingly.

We are studying the problems of transition in the Research Division of the Committee for Economic Development (C.E.D.). The one basic objective of all of these studies is to get our peacetime industrial machine into high gear at the earliest possible date. The importance of this objective cannot be too strongly emphasized. Practically every specific postwar problem which the author will discuss can be solved only by the rapid attainment of higher levels of production than we have ever known in times of peace. If we can achieve such production levels, the employment problem will largely take care of itself, the great threat of postwar inflation will be eliminated or greatly lessened, and the problem of balancing our Federal budget and of carrying the tremendous load of governmental debt can be solved.

How vital the time factor will be in the solution of these problems must be emphasized again and again. Since Pearl Harbor, we have recognized that every day saved in the expansion of war production is of the utmost importance for the achievement of victory. We have gladly expended many billions of dollars for the sake of the utmost speed in our war effort which could undoubtedly have been saved if we had been able to do the job in a slower and more orderly fashion.

The stakes for which we shall be playing in our efforts to win the peace will be no less than those of the war, and speed will be every whit as essential. Neither business nor the Government can afford to be guided by cautious, penny-pinching tactics if the job is to be done.

TERMINATING WAR CONTRACTS

The first problem we shall face after the defeat of Germany will be an extensive termination of outstanding war contracts and the settlement of claims in connection with such terminated contracts. As a matter of fact, this problem is at hand. It will be of interest to know that the total dollar value of contracts already terminated is considerably in excess of the dollar value of all contracts terminated after the end of the first world war.

In furtherance of our basic objective of attaining high levels of peacetime production at the earliest date, we naturally believe in a prompt cancellation of all contracts which are no longer needed for the war effort. Thus, we believe that any policy of continuing to produce unneeded war goods merely for the sake of maintaining employment will slow down the reconversion of industry. Instead, we are convinced it will be far less costly from the standpoint of the national economy to cancel these contracts promptly and to provide adequate compensation for the workers thrown out of employment.

Speedy settlement of terminated contracts will be necessary to free working capital and to clear plants of wartime inventories and equipment. A rapid unfreezing of working capital will be of particular importance for many thousands of small businesses which will have their limited financial resources so tied up in war work that they will be unable to convert to civilian production until their working capital is released.

Effecting speedy settlement of more than 100,000 prime contracts and more than 1,000,000 subcontracts will be a task of immense proportions. The C.E.D. has been studying this problem for several months and has recently made recommendations for new legislation designed to expedite the release of business funds now tied up in war production. We are convinced that unless drastic action is taken by the Congress in this connection the reconversion of industry may be disastrously delayed.

DISPOSING OF GOVERNMENT-OWNED PLANTS

Another important problem we shall face at an early date is that of disposing of government-owned plants and wartime surpluses of commodities and equipment. The C.E.D. is now engaged in a study of this subject and as yet has reached no definite conclusions in this connection. With regard to the disposal of government plants, assurance is given that our policy will be based on the assumption that the only proper objective will be to get these plants into operation under private management as rapidly as possible. In this connection, it may also be pointed out that the problem of disposing of these plants quickly by sale may be exceedingly difficult to work out because if they are sold at a price low enough to justify their purchase on a business basis the political outcry is likely to be terrific and in the long run might be very harmful to business. We are therefore tending toward the conclusion that perhaps the most satisfactory immediate policy for the disposition of the plants and equipment may be that of a simple leasing arrangement with possibly the right to apply the rental paid against eventual purchase price.

Above all, we must not forget that our basic objective must be to get these plants into operation under private management at the earliest possible date and not permit ourselves to become involved in long controversies over detailed methods. It is realized that many businessmen are concerned over the possibility that the Federal Government may wish to operate many of these plants in competition with private business. At pres-

Contributed by the Management Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

ent, however, the author is sure there is very little cause for concern in this direction. In many discussions of this subject in Washington, no real sentiment has been found in favor of such a plan. The only danger in this connection might arise in the event of a prolonged failure to get these facilities into operation, coupled with a long period of mass unemployment throughout the country. Under such circumstances, there could well develop a strong demand on the part of unemployed labor for government operation.

SURPLUS MACHINERY AND MATERIALS

The problem of disposal of surplus machinery and materials also presents serious difficulties. Most readers will remember the disastrous effects on business of the dumping of war inventories at the end of the last war, and it is believed that very few would wish to repeat that experience. Nevertheless, it is very important to bear one fact in mind. Businessmen cannot afford to insist upon liquidation of wages and other factors of production and at the same time refuse to accept any liquidation in the prices of their own particular products. Again the objective must be to reach high levels of production as rapidly as possible and this will be impeded if business insists on a policy of holding off the market wartime inventories and machinery which might otherwise be used. The only sound policy for a business firm which has some goods which cannot be sold at the original sale price is to mark them down to a price where they can be sold and move them out. These goods must be moved into circulation as rapidly as can be achieved without adopting a chaotic policy of wholesale dumping. In other words, business must be prepared to assume its fair share of the cost of postwar liquidation, particularly if it wishes to ask for a similar liquidation of wartime wages. Any other policy will slow down production and increase the threat of inflation.

DEMOBILIZATION OF ARMED FORCES

Perhaps the key problem of all in the transition period will be that of effecting an orderly demobilization of our fighting forces and of the transfer of civilian workers from wartime production to civilian occupations. The author has had access to a great variety of figures as to what this transfer will mean in terms of human beings and is not sure that anyone has figures that can be relied upon. It seems likely, however, that somewhere between 20,000,000 and 30,000,000 individuals or 40 to 50 per cent of our total working-fighting forces will be involved in occupational changes when the war ends. One of the most difficult problems we shall have to face in this connection will be that of coping with particular geographical areas where the distress is likely to be especially acute. There are many communities which have had mushroom growth during the war because of the enormous expansion of the aircraft and shipbuilding industries. The readjustment problems of such communities are certain to be terrific and some very difficult shifts in population are clearly indicated.

The C.E.D. is now engaged in a study of manpower-demobilization problems but it is certain that there are no easy answers. These problems will have to be tackled from many different angles at the same time. The armed services are already hard at work on plans looking toward an orderly demobilization of their forces. The real problem in this connection, however, is whether or not the American public will tolerate any plans for an orderly demobilization. When the war ends the pressure of our fighting men to get home and of their families to have them home at the earliest possible date will be terrific and very difficult to resist.

The postwar threat of inflation is of as great concern as any other single thing in the postwar picture. At the end of the war the unused purchasing power in the hands of our citizens will be fantastically great. Present estimates indicate that individual savings by the end of 1944 may approximate \$100,000,000,000. These funds provide our greatest assurance that a market will be ready to absorb a greatly increased output of goods and services. They also constitute a serious inflationary danger unless goods and services are speedily forthcoming.

Because of this danger most thoughtful students now recognize the necessity of maintaining many of our present wartime controls on prices, wages, rents, etc., for some time after the close of hostilities. However, the worry is not what the Government may decide to do in this connection but what the American people will stand for. When the end of the war removes the strong patriotic motive for compliance with unpopular O.P.A. controls, the author fears that the pressure to rush into the market and buy everything in sight, regardless of regulations, may be very strong. The only cure for this situation will be the attainment of new high levels of production at the earliest possible date. In the meantime, there will be the need for a degree of self-discipline and self-restraint on the part of the American people which may be very difficult to achieve.

POSTWAR TAX PROBLEMS

Although it is not strictly a transitional problem, the matter of postwar taxes must be considered. It is generally agreed that if business is to do its full share in the attainment of high levels of employment and production, there is a prime need for tax reform which will remove the present impossible burden which has been placed upon business enterprise.

No tax reform is possible except one that is related both to the expected level of the postwar Federal budget and in turn to the level of our national income. The author has recently studied some careful estimates of the postwar Federal budget and is convinced we must look forward to annual Federal expenditures for the first postwar decade which will average around \$20,000,000,000. On the most hopeful assumption that the war in Europe will be over before the end of 1944, and that with Japan before the end of 1945, we shall be faced with a total Federal debt of at least \$250,000,000,000 when the war is finished and liquidated. This debt will require annual interest charges of at least \$6,000,000,000 and perhaps \$7,000,000,000 annually for the first postwar decade.

Let us next consider the relationship between the Federal budget and the national output of goods and services. The latest estimates place the gross national product for 1943 at about \$188,000,000,000. At this level, it is now believed that Federal tax revenue for the fiscal year ending June 30, 1944, will be over \$40,000,000,000, without any further increase in taxes.

If we achieve the postwar employment goal of 55,000,000 civilian workers, the national output of goods and services may be as high as \$140,000,000,000 in terms of 1940 prices. Postwar prices, however, are certain to be much higher than those of 1940. If the postwar price level should average 50 per cent higher than that of 1940, it would mean that a gross national product of \$140,000,000,000 in 1940 prices would actually be \$210,000,000,000 in terms of postwar prices.

The conclusions from these figures is that the existing tax structure, if maintained after the war, might yield over \$40,000,000,000 as compared with an estimated budget requirement of \$20,000,000,000. This means that a satisfactory postwar level of production may make possible a very substantial cutting of tax rates and still permit a balancing of the budget. The higher we can raise our national production the less will be our burden of taxes. There are definitely encouraging aspects to the outlook which are listed as follows:

1 With a high level of production, we can carry the tremendous load of governmental debt and balance the budget, while achieving a substantial measure of tax reduction.

2 We shall emerge from the war with the broadest income-tax base in our history. This means that practically every wage earner in the country will for the first time have a direct and personal interest in governmental economy.

3 There are good reasons to hope that tax reforms will be

(*Continued on page 134*)

Increasing TOOL LIFE *by* *Better* TOOL FINISHING

By V. H. ERICSON

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SCIENCE and system have been established in the art of metal cutting by the pioneer work of Taylor, Boston, and Ernst. During the periods when properties and shape of the tool, feeds, speeds, and lubricants were being selected, more or less attention was given to finish on the tool. Hand honing probably was practiced from the first time a tool ever was sharpened on a grinding wheel.

In the old days, the toolmaker would grind his cutting tool on a natural stone wheel and afterwards spend considerable time honing the edge before putting the tool in use. With the advent of high production and new shapes of cutting tools, the quickest way was resorted to, and finish was a secondary issue. It has always been considered that a keener edge and higher surface finish should produce better results, but it was the opinion of the majority that any additional work put on a cutting tool to produce a better edge was not worth while and any attempt to introduce another grinding operation was always met with a reply that it would be impractical to add to the cost of regrinding.

It is only recently that any definite information has been compiled on the effects of better finishes on cutting tools. The author was fortunate to have been engaged on some of this work in 1938, long before any shortage of cutting tools existed. It may be of interest if we relate just how our part in this development originated.

INVESTIGATING TOOL-GRINDING PROCEDURE

In the early part of 1938, C. J. Lindegren, assistant superintendent of Crompton and Knowles Loom Works, Worcester, Mass., was delegated by his company to investigate tool costs. Being a typical tool engineer, he first made a check to determine what kind of tools the company was buying and found them to be the best tools obtainable. His next step was to investigate the equipment on which the tools were being used. This investigation showed that most of the equipment was new and that which was not new had been put in good condition. It was then and then only that he started to investigate the method of grinding being used, and the author's company was called upon to give advice.

The method of grinding was found to be correct, following the usual procedure practiced in the average toolroom. The operators were men of long experience and were what one would classify as experienced grinder hands. The wheels they were using were typical tool-and-cutter grains and grades, but it was thought that the results could be improved upon by employing a slightly finer grit and a freer cutting wheel. Such a wheel was tried and the edge it produced was much better than that produced with the regular wheel. Two tools, one sharpened with the old wheel and one with the new wheel, were shown to the workmen as a visual examination revealed a marked difference in the two edges; the new wheel also helped to eliminate any likelihood of burning the cutting edge. Examination of these same edges under a magnifying glass revealed to a far greater extent the improvement that had been made.

At this stage of the work the following questions developed:

1 What is a cutting tool?

Obviously it is an instrument that has one or more sharp edges used for removing surplus material.

2 Why does it wear out?

Because the cutting edges break down, become dull, and fail to cut off the surplus as quickly and smoothly as modern methods demand, thus requiring regrinding to renew its original effectiveness.

3 Why does it become dull?

Because for some reason the cutting edge becomes defective and cannot do the work demanded of it. It is no longer a good edge.

4 What is a good cutting edge?

A good edge should be an unbroken line at the junction of two planes, usually forming an acute angle.

5 Why must the line be unbroken?

To equalize the load placed upon the edge.

With the foregoing theories in mind a visual inspection of various tools was started in the process of which both used and new tools were examined with inconclusive results. The microscope was then resorted to and found what the eye had failed to see. Photomicrographs at 100 magnification demonstrated clearly the results of this study.

Enlisting the aid of an artist we conveyed to him our conception of a rough-ground edge and what happens to it when put in use. He proceeded to make three sketches which are reproduced herewith, Figs. 1 to 3, inclusive. Note the hills and valleys running into each other, in Fig. 1; not hill to hill and valley to valley, but haphazardly, causing a ragged broken line of peaks and valleys. It is quite obvious what takes place when the cutter is put in use. The unsupported peaks are unequal to the heavy load imposed upon them and quickly break off leaving flat spots that nub instead of cut, Fig. 2. This places a greater load on the remaining edge which in turn fails more quickly than it would if the edge were straight and the load equally distributed. In the meantime these flat spots continue to abrade, tearing the stock off instead of giving a smooth, clean cut. At the same time, through friction, heat is generated which eventually affects the entire cutting edge and, naturally, the hardness of the cutter. The net result is a dull tool. Fig. 3 represents the theoretical good cutting edge defined previously, i.e., the straight unbroken line at the junction of the two planes.

TOOL-FINISHING OPERATION DEVISED

The next step was to devise an economical method of removing the hills and valleys, approaching as nearly as possible the straight unbroken line. To perform this operation a fine-grit "Crystolon" shellac wheel was used with very good success on the tool-and-cutter grinders and surface grinders. Before going into this additional operation, it was arranged to have records of the production obtained from the cutters, as commonly ground, to compare with cutters which were given the keener edge and high surface finish. This was necessary in order to ascertain whether or not it would be economical to add this finishing operation.

The following illustrations show what was accomplished by

Contributed by the Special Research Committee on Cutting of Metals and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

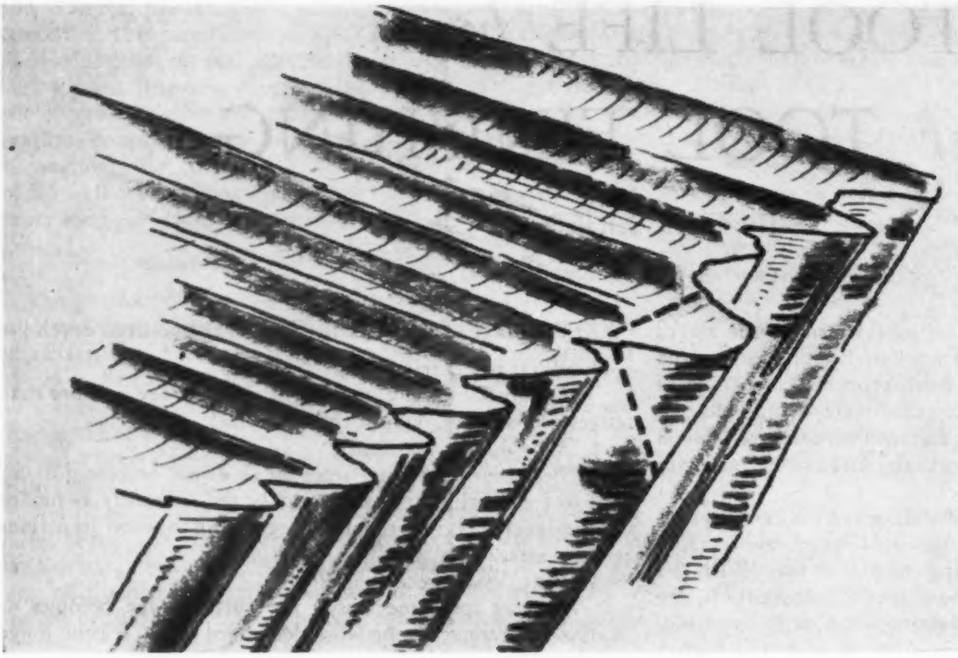


FIG. 1 ARTIST'S CONCEPTION OF ROUGH-GROUND CUTTING EDGE

the use of the fine-grit wheel. Fig. 4 shows a 3.5 × 0.372 × 1.5-in. splining cutter, the arrow indicating the point shown in subsequent views. Fig. 5 shows the cutting edge of the same cutter as commonly reground. This finish is typical of what is obtained in many shops, but it does not represent as good a finish as can be obtained with a wheel in this grit size. Proper manipulation by the operator will produce a better finish, but this takes almost as long as mounting the finer-grit wheel and finish-grind. The finer-grit wheel has the psychological effect on the operator of warning him that this wheel is for finishing and not for removing any stock. Fig. 6 shows the same cutting edge after the cutter had been sharpened with the fine-grit wheel. Note that the peaks and valleys have been removed and how the edge is approaching the straight unbroken line considered essential for good cutting qualities.

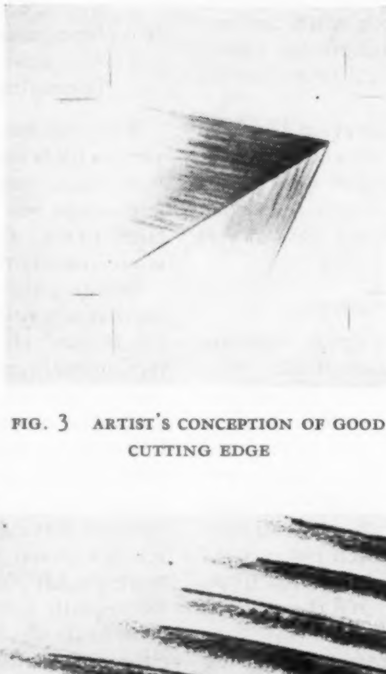


FIG. 3 ARTIST'S CONCEPTION OF GOOD CUTTING EDGE

Realizing, of course, that one kind of a figure does not completely describe a surface, profilometer readings may be mentioned. On tools of various metals, 46- and 60-grit wheels may produce a smoothness of from 20 to 30 μ in., rms; this represents the average. Others are using these same grit sizes and obtaining 8 to 12 μ in., rms. The fine finishes under discussion typically range from 2 to 5 μ in., rms.

FIG. 2 DULLING OF CUTTING EDGE OF ROUGH-GROUND CUTTER

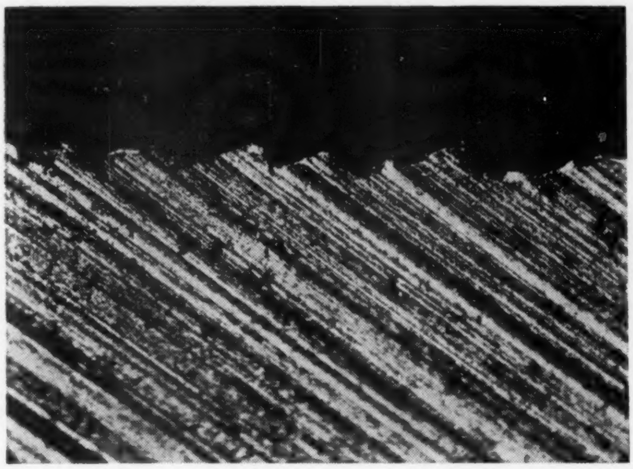


FIG. 5 CUTTING EDGE OF SPLINING CUTTER AS COMMONLY RE-GROUND

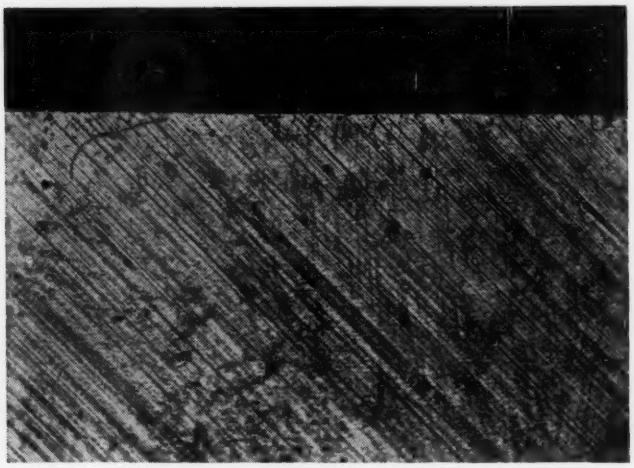


FIG. 6 CUTTING EDGE OF SPLINING CUTTER GIVEN HIGH SURFACE FINISH AND KEEN EDGE

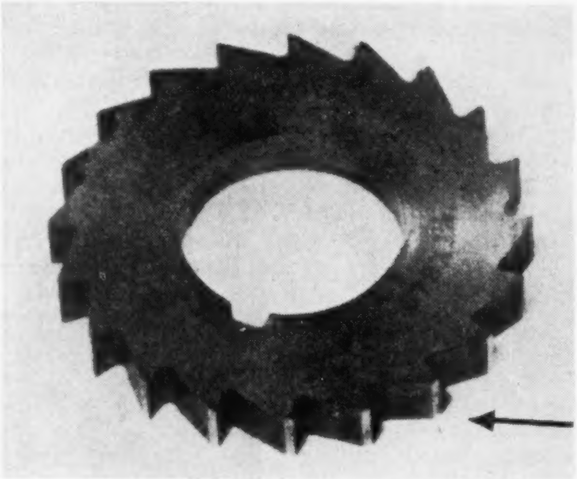


FIG. 4 SPLINING CUTTER, 3.5 × 0.372 × 1.5 IN.

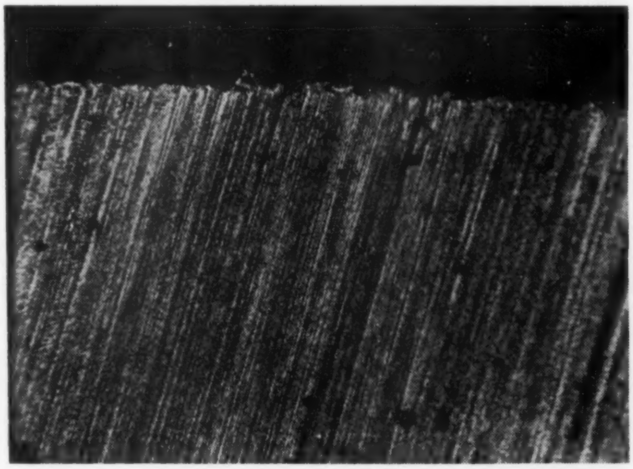


FIG. 7 GEAR-SHAPER CUTTER EDGE AS NORMALLY SHARPENED

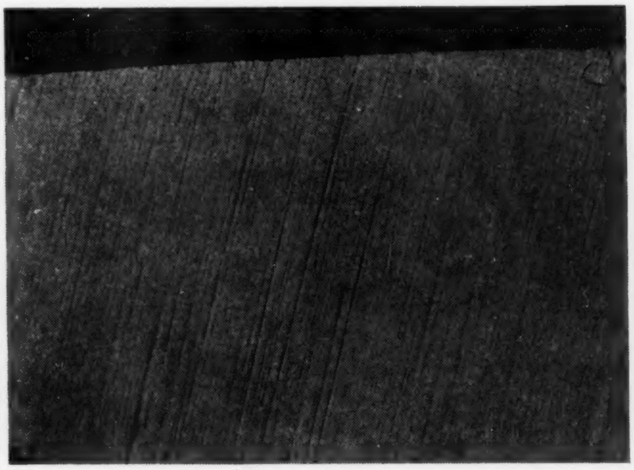


FIG. 8 GEAR-SHAPER CUTTER EDGE GIVEN HIGH SURFACE FINISH AND KEENER EDGE

Smoothness of finish, of course, is influenced by factors other than the kind of abrasive and grit size in the wheel or honing sticks. These are strength of bonding of the abrasive body, dressing of the abrasive wheel,[1] skill and procedure of the operator, rigidity of the setup, and properties of the tool material. Harder tools and harder wheels lead toward finer finish. It goes without saying that the finishing wheel should be applied only for finishing. To attempt to use it for roughing leads to trouble, such as excessive wheel wear or injury to the work through overheating.

[1] "More Cuts by Correct Sharpening," by R. T. Wise, *American Machinist*, vol. 85, 1941, pp. 1314–1316.

Little need be said about work quality for obvious reasons. When there is no built-up edge on the tool point, finish on the work will be finer and more accurate when the tool edge is keener and when the flank of the tool, on which the work body slides, has a finer finish.[2] When there is a built-up edge, it (the built-up edge) will be less ragged and will have less tendency to tear or corrugate the work surface when the tool edge has been made more nearly perfect by fine finishing.

SHARPENING GEAR CUTTERS ON FINE-GRIT WHEEL

Gear cutters were being sharpened on a rotary grinder, employing a wheel similar in grain and grade to the wheels used on the tool-and-cutter machines. The fine-grit wheel was applied here and some improvement was made as will be noted in the following illustrations:

Fig. 7 represents cutters as normally sharpened. It will be observed how much better finish was obtained on this edge, as compared to the finish obtained on the cutter ground dry on a tool-and-cutter machine, even though the same grain and grade were used. This illustrates how good finishes can be obtained when more rigid equipment is used. The wheel was dressed with a diamond truing tool held rigidly and the grinding was performed with a grinding coolant. All these factors favor a better finish.

Fig. 8 shows the improvement made when the fine-grit wheel was used. On this machine the changing of a wheel requires considerably more time as compared to dismounting and mounting a small tool-and-cutter wheel. The procedure in cases of this kind is to accumulate a dozen or more cutters, rough-grind them, put on the fine-grit wheel, and then finish the entire lot.

ADVANTAGES OF KEENER EDGE AND HIGH SURFACE FINISH

The question now arises: What advantage is derived from a keener edge and high surface finish? To determine this, records were kept as requested and they revealed that considerable improvement was made in production between regrinds varying from 9 per cent up to 300 per cent increase. The following discussion relates some actual figures on gear cutters, milling cutters, and punches and dies.

Actually the benefits derived were many, some of the advantages as we found them being as follows:

1 Longer life of cutting tools because resharpenings are fewer.
2 Fewer grinding wheels used.
3 Increase in work between regrinds.
4 Less power consumption.
5 Better quality of work produced.
6 Cutter teeth of uniform height.
7 No holdup in production in waiting for tools to be sharpened.

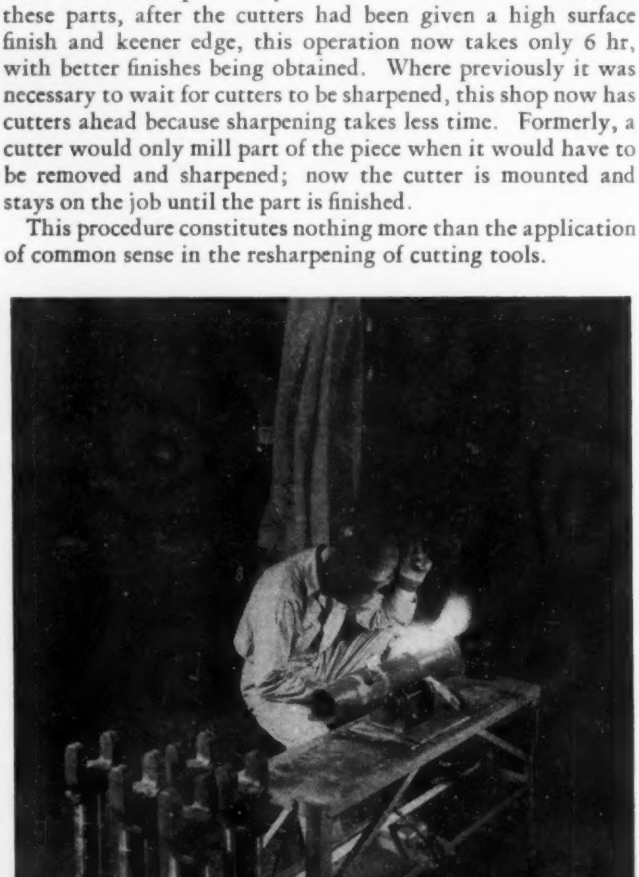
There is no doubt that it pays dividends to put a better edge and higher surface finish on cutting tools. It may be accomplished in the same manner, as explained in this work, or it may be done by using the type wheel being used currently, in any particular shop, or one with finer grit and softer grade, in one operation. When using a type wheel that previously has not given entirely satisfactory results let it die out longer so as to remove the high peaks. Naturally, some operators in reading about this work will try the same method as mentioned. It may therefore be of interest to relate the experiences of others who have done so because they substantiate the results obtained in the plant cited previously.

In one plant the job of reaming aluminum castings was continually giving trouble. The reamers were $1^1/_2$ in. diam, and the castings were made of No. 21 aluminum. Some reamers were sharpened by using the fine-grit shellac wheel and, where they previously had required sharpening twice a day, they are now ground only once every 2 or 3 days. On the average a reamer is now sharpened once as compared to 5 times previously. On this basis the reamers should last 4 times longer; and the same applies to the grinding wheels. The finish produced was also much better. Production is now down only once for changeover, as compared to 5 times previously.

Another large plant has adopted a fine-grit shellac wheel for sharpening large hobs used for cutting large reduction gears. It is found that when the hobs now come back for regrinding the teeth are burned back so little that only 0.010 in. has to be ground off as compared to 0.060 in. formerly. The time of grinding has been reduced to 5 hr, as compared to 17 hr previously. Finish is far better and cutters last for a much longer period.

In yet another operation at this same plant, some large parts were being milled which required more than ordinarily good finishes. Where previously 16 hr were needed to finish-mill these parts, after the cutters had been given a high surface finish and keener edge, this operation now takes only 6 hr, with better finishes being obtained. Where previously it was necessary to wait for cutters to be sharpened, this shop now has cutters ahead because sharpening takes less time. Formerly, a cutter would only mill part of the piece when it would have to be removed and sharpened; now the cutter is mounted and stays on the job until the part is finished.

This procedure constitutes nothing more than the application of common sense in the resharpening of cutting tools.



LANDING-GEAR STRUTS

(Landing-gear struts for one of America's newest and fastest fighters are now being manufactured in Akron by The B. F. Goodrich Company. The work of constructing the shock struts capable of sustaining high-speed landings and take-offs is being done in the company's metal-products division.)

[2] "Fine Tool Finish Increases Tool Life 2000 Per Cent," by C. J. Wiberg and W. K. Heath, *Iron Age*, vol. 150, July 23, 1942, pp. 33–37.
"Polishing Cutting Surfaces," by H. J. Chamberland, Hitchcock Machine Blue Book, May, 1940.
"Increasing the Life of Cutting Tools by an Improved Method of Grinding," by L. J. C., *Machinery*, (London, England), vol. 56, 1940, pp. 431–434.

Applying PREPARED ATMOSPHERES *to* METAL PROCESSING

By E. G. de CORIOLIS

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MOST metals, at some stage of their processing from bar or casting to finished product, require that they be heated. The purpose may be simply to plasticize in order that the metal may be more readily shaped by mechanical pressure such as in forging, pressing, or upsetting. Or the internal structure may require a change which will render it amenable to cutting, shaping, or drilling, in which case the metal is subjected to annealing or normalizing. Again it may be desired to affect only the metal surface without altering its internal structure as in skin hardening. Or the hardening of the surface may also be accompanied by an internal structural change such as in carburizing. Finally, the purpose may be to join pieces of the same metal by means of a dissimilar metal, such as in brazing. For the general purposes of this paper the art of welding is not included.

The art practiced by the blacksmith has long since passed from the scene of modern American industrial operations. Some of his processes are still extant since they are fundamental, but methods of application now are such as hardly to be recognizable. Many new processes, of which he was totally unaware, have been added. In all these it is required that heat be applied in some form, and it is mostly with the mechanics of application that we are here concerned. Since in point of tonnage handled and variety of processes involved steel articles by far outweigh all other metals, the discussion will largely be confined to this one dominant metal.

The one outstanding characteristic of metallic iron is that it most readily oxidizes. It does so at ordinary temperatures in moist air when it forms rust. When heated this oxidation takes the form of black oxide or mill scale. The blacksmith was quite familiar with this fact and his observations had led to the discovery that by manipulating the metal properly while heating in an open fire, he could minimize if not completely eliminate the formation of scale. This might be cited as possibly the first known application of an atmosphere to the processing of metal.

Most common metals oxidize when heated in the presence of air. The oxide is generally undesirable in modern practice. Some of it may be tolerated. Usually most of it would be eliminated if the means were available or the cost permissible. There are some exceptions. The resistance to corrosion of heat-resisting alloys, largely used in furnace mechanisms, is attributable to light surface oxidation of the chromium in the alloy which forms an adherent film protecting the metal from further oxidation.

When a steel ingot is heated in a soaking pit prior to rolling, a certain amount of oxidation is desirable as the scale so formed eliminates many surface defects resulting from casting the ingot. But this surface oxidation must be controlled within certain limits beyond which wastage of good steel would result, together with excessive chipping costs after rolling.

Control of oxidation is accomplished by the rate of heating combined with the method of applying the fuel. The same means are employed when heating steel for forging. The best example of this art is the rotary billet furnace now in use for forging high-explosive shell. The heating chamber is maintained under pressure at all times by mechanically operated dampers responsive through electrical means to the internal pressure of the furnace. Even when the manipulating doors are opened for inserting a cold billet or extracting a hot one, there is sufficient pressure to cause furnace gases to shield the openings against air intrusion. The furnace is fired by a multiplicity of special proportioning burners in which the character of the flame may be varied from that of clear to luminous combustion and in zones which are held under close thermostatic control. Nothing is left to the operator except to wield the mechanical manipulator. The result is that scale formation is light and the character of the scale is so controlled that it breaks off freely during the pressing operation. The rough forging is so clean that it goes directly to the forming lathes without requiring pickling or sandblasting.

The foregoing is a good example of a combination of well-engineered elements which make possible the application of controlled atmosphere to metal heating. It is, however, a relatively simple operation in that the fuel itself constitutes the atmosphere and the rate of fuel input determines the volume of gases available to protect the work. Were it necessary to heat the steel with total absence of scale, the furnace would become far more complicated. It would involve the application of an extraneously prepared atmosphere, and it is with such atmospheres that this paper is principally concerned. Further along will be cited methods for scaleless forging but, first, consideration should be given to a brief description of atmospheres and their preparation.

PREPARATION OF ATMOSPHERES

The principal sources for the preparation of atmospheres used in the processing of metals are charcoal and fuel gas, charcoal providing a source of carbon, and fuel gas, mostly natural gas, providing a source of carbon, hydrogen, and methane. The methods of preparation are comparatively simple in principle. They involve mostly partial or complete combustion with air, the end product varying depending upon the type of gas it is desired to produce.

The purest atmosphere prepared from charcoal is made by retorting it in its downward passage through a refractory tube externally heated. The charcoal is loaded in a sealed hopper at the top. During its slow downward progression it encounters a stream of gas formed by introducing air at the base of the heated retort. This gas distills off the volatile products together with the moisture contained in the raw charcoal, leaving a residue of highly activated and, save for the ash content, purified carbon. The volatiles and moisture are allowed to escape at the base of the hopper. At a point sufficiently below this to have allowed the charcoal to carbonize, the prepared gas is removed by suction. As Table 1, showing the chemical composition, indicates, this gas, atmosphere No. 1, is practically a pure mixture of carbon monoxide and nitrogen and provides one of the best prepared atmospheres. If sufficient care has been exercised in its preparation, the gas will be practically moisture-free, having a dew point of —40 F or lower. As will appear

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later, this low dew point is a very valuable and important characteristic of prepared atmospheres.

There are several other methods of preparing gas from charcoal. One operates on the suction-producer principle. Air is admitted beneath the grate of a refractory-lined chamber, and suction is applied at the top. Reaction proceeds by partial combustion. It is an impure gas but has its uses for certain operations. Its principal advantage is its cheapness and the simplicity of the apparatus. It requires no extraneous heating (atmosphere No. 2).

The principal objection to the preparation of atmospheres from charcoal is the lack of continuity of the methods as now in use. Charcoal must be charged intermittently into the feed hoppers and ashes have to be removed. This is not a very clean operation and encounters some objection from operatives. In addition, good grades of hardwood charcoal are getting scarce and difficult to procure due to other war demands.

In terms of volume produced, atmospheres prepared from fuel gas by far exceed all other types. Their principal advantage is continuity of operation under automatic control coupled with low cost of operation and upkeep. Quite a variety of atmospheres are so produced. In point of predominant utilization, natural gas is the chief source of fuel. Next come liquefied petroleum gases, butane, and propane. Where artificial gas of constant composition is available, it may be utilized but its sulphur content must be reduced to the lowest possible values.

The simplest of these atmospheres is produced by burning the gas nearly to completion in a closed chamber and cooling the products either through a shell-and-tube cooler or through direct contact with water in a tower filled with packing material. This is a cooled flue gas, (atmosphere No. 3).

A modification involves reducing the amount of air mixed with the gas to about $^6/_{10}$ of that required for complete combustion. Such a mixture when burned in an insulated chamber will maintain its combustion without snuffing out. The resultant gas is much richer than flue gas. It is usually cooled in a shell-and-tube cooler, after which the moisture content is further reduced by refrigerating it to slightly above freezing (atmosphere No. 4). For certain purposes, further dehydration is accomplished by passing over activated alumina or silica gel when the dew point is lowered to —40 F. These adsorbing materials are, respectively, the precipitated and calcined oxides of aluminum and silicon. They are composed of granules which are extremely porous and have the property of adsorbing water vapor at ordinary temperatures. Revivification is accomplished by heating to approximately 300 F, followed by cooling.

A further modification consists in processing the flue gas to remove its content of carbon dioxide. The fuel gas is burned to practical completion; the carbon dioxide is absorbed by a chemical such as monoethanolamine, which is constantly regenerated, and the decarbonated gas is dehydrated as in the preceding case, leaving as residue nitrogen of 97 per cent purity or higher (atmosphere No. 5). In all these cases the reactions have been autogenous in that the reacting gas has supplied its own heat of reaction.

Next for consideration are the so-called cracked gases in the preparation of which the heat of reaction is provided almost wholly from extraneous sources. There are several modifications of this method, the simplest comprising passing a preformed mixture of fuel gas with a very limited supply of air, approximately 1 volume of natural gas to 2.5 volumes of air, through a heated retort filled with a supported catalyst and immediately cooling the resultant gas. This atmosphere consists mainly of carbon monoxide, hydrogen, and nitrogen with less than 1 per cent of residual methane, and a dew point of zero to —10 F (atmosphere No. 6).

Finally, mention might be made of atmospheres prepared from anhydrous ammonia. The most common is that produced by passing the gas through a heated retort. The cracked gas is a pure mixture of hydrogen and nitrogen and completely anhydrous (atmosphere No. 7). Due to its explosibility, it is sometimes modified by partial combustion of ammonia with air, followed by dehydration and mixing with cracked ammonia. The nitrogen content is thus considerably appreciated, and the moisture becomes less dangerous to handle.

TABLE 1 COMPOSITION OF PREPARED ATMOSPHERES

Gas constituent	Type of atmosphere						
In per cent	No. 1	No. 2	No. 3	No. 4	No. 5	No. 6	No. 7
Oxygen	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Carbon dioxide	0.0	0.2	10.5	5.0	0.2	0.0	0.0
Carbon monoxide	34.7	31.0	1.5	10.5	1.5	20.7	0.0
Hydrogen	1.2	5.0	1.2	12.5	1.2	38.7	75.0
Methane	0.0	1.0	0.0	0.5	0.0	0.8	0.0
Water vapor	Trace	0.8	3.5	0.8	Trace	0.1	0.0
Nitrogen	64.1	62.0	83.3	70.7	97.1	39.7	25.0

FUNCTIONAL UTILITY OF PREPARED ATMOSPHERES

To those not familiar with the art, the atmospheres cited would appear to be a bewildering array from which to make a choice. It is true that the functions of some of these atmospheres are overlapping, and a great many if not all industrial operations could be performed by utilizing fewer atmospheres than all those listed. Nevertheless, they all have their utility, and the choice in many cases would be dictated by the factors of availability and cost. Since the analysis of such factors does not fall within the scope of this paper, it would be useful to consider the utilization of these atmospheres functionally.

Many metals will also oxidize in hot flue gases containing no free oxygen. The oxidizing agents in such case will be the products of oxidation of the fuel itself, namely, carbon dioxide and water vapor. But the most common of all metals, steel, which constitutes the greatest tonnage and variety in heat-treating, is also affected in its composition by the change which occurs in its carbon concentration. Whereas the choice of atmospheres when treating other metals resolves itself simply to the question of preventing oxidation, in the case of steel, this is complicated by the question of carburization or decarburization, whether the treatment will add to or deduct from the carbon content of the surface under treatment. It is not proposed to deal extensively with all the conditions influencing these changes. The equilibrium of these various gases at heat-treating temperatures has been studied and publicized. For those interested, a bibliography is given at the end of the paper.

The effect on steel of the behavior of these gases may be summarized briefly. Oxygen attacks steel at all temperatures. It also decarburizes. Carbon dioxide at heat-treating temperatures oxidizes and decarburizes. Water vapor behaves in a manner similar to carbon dioxide. Dry hydrogen is a deoxidizer and very mild decarburizer. Moist hydrogen is a powerful decarburizer. This specific point is worth noting. Carbon monoxide is a deoxidizer and, at low temperatures, a mild carburizer. Methane deoxidizes, but its principal function is that of a carburizer at elevated temperatures. Dry nitrogen is inert at all temperatures. For easy references these properties are given in Table 2.

TABLE 2 EFFECT OF VARIOUS GASES ON FERROUS MATERIALS

Gas constituent	Reaction: Pure iron	Iron oxide	Iron carbide
Oxygen	Oxidize	..	Oxidize-Decarburize
Carbon dioxide	Oxidize	..	Oxidize-Decarburize
Carbon monoxide	Carburize	Reduce	......
Hydrogen	..	Reduce	Decarburize
Water vapor	Oxidize	..	Oxidize-Decarburize
Nitrogen	..	..	......

TYPES OF EQUIPMENT

The next question to be considered is that of the equipment in which these several processes are carried out. It has already

been shown that the burning of fuel gas produces carbon dioxide and water vapor, both of which are oxidizing to steel. It is obvious, therefore, that furnaces for the heat-treatment of steel in extraneously produced atmospheres must be heated by indirect means. For the case of fuels, liquid and gaseous, this is accomplished by one of two means, i.e., the muffle and the hot tubular element, also called the radiant tube. Muffles are chambers of heat-resisting metal or refractory material housed within a furnace structure with burners on the outside of the muffle transmitting heat through its walls to the work contained within. The radiant tubular element acts as a conduit for burning and burnt gases, the heat from which radiates from the walls of the tube to the work contained within the furnace chamber which houses these radiant elements. In so far as the work is concerned, this method of heat application is no different from that of the electric resistor. One element becomes heated and continuously emits heat because it is constantly receiving heat from a burning fuel; the other does likewise because it is constantly opposing flow of an electric current. Their rate of heating is a function of the safe heat input per unit of area and the total area of element contained within the furnace structure.

The question frequently arises as to the relative merits of these two methods of indirect heating. The answer lies entirely within the realm of economics of operation and has nothing to do with individual preferences. There are some few operations which can best be conducted by using electric-resistor furnaces. Likewise, there are others which require they be heated by radiant tubes. But by far the greater number of heat-treating operations can be performed equally as well by the application of electric resistors or radiant tubes. If one were engineering furnaces for installations at or near Grand Coulee, there would be very little hesitation as to the choice of electricity as the heating medium. But for locations in most other parts of the country, and more particularly where natural gas is now distributed, the radiant-tube furnace would have a preponderant advantage in operating cost.

Muffles possess the advantage in that they can be heated by any fuel, although these are usually restricted to fuel gases. They present many advantages in operation and are to be recommended when the structures involved are of limited size, say, 20 ft long and 3 ft wide. Beyond these dimensions, muffles become unwieldy and are likely to result in high maintenance cost. They have also the serious defect that once the muffle springs a leak, it is almost impossible to stop it without shutting the furnace down for several days and removing the muffle for repair. Such delays may prove quite serious in a plant working at peak production. The radiant-tube furnace on the other hand can be so designed that a leaky tube may be capped and the furnace continued in operation for a short period of time, after which the tube may be removed while still hot and repaired or replaced by a new element. It is not unusual to make such tube changes in a matter of a few hours. For this and many other reasons, radiant tubes lend themselves particularly to heating large furnace structures.

ATMOSPHERE-FURNACE CONSTRUCTION

These furnaces usually consist of suitably reinforced steel plate structures, welded gastight and internally lined with suitable refractory material. For most operations, ordinary firebrick cannot be used as a refractory, because it is attacked by many of the atmospheres used in these furnaces. The lightweight refractories are generally selected because they are usually made from high-grade materials which are not affected by these atmospheres and for their insulating value which makes it possible to reduce wall thickness. For carrying loads within the furnace structure or where mechanical strain is applied, hard-burned refractories of high purity are in use which are capable of withstanding attack by highly reducing atmospheres.

The design and construction of the furnace housing are by far the simplest phases of the many problems which have to be faced in building an atmosphere furnace. The type of heating element is likely to influence considerably the design of the structure. Generally speaking, electric resistors are more easily applied than radiant tubes. The connectors being few in number involve fewer holes through the furnace shell which have to be guarded against leakage, and expansion of elements takes place within the furnace chamber. Radiant tubes require more perforations through the furnace wall and expansion of these tubes may present a problem. Probably one of the best methods so far devised to take care of this expansion is to construct the tube in the form of a hairpin, with the return bend floating freely inside the furnace. Where conditions permit, and with a view to reducing the number of wall openings, the tube is built as a "W." This results in nearly doubling the radiating surface of the tube for the same number of wall openings.

Location of the heating elements is a matter requiring special consideration. The electric resistor enjoys the advantage in that it can be applied in confined spaces and be made to conform generally to the structures to be heated. There is one limitation, however, in that it is usually preferable to keep them off the floor of the furnace due to the possibility of material falling on the exposed element and causing a short circuit. The radiant hairpin tube has no such limitations and can be applied equally as well vertically or horizontally, under the furnace arch or above the furnace floor. Its ideal application is where it can be hung from the furnace arch, in which case it requires no support except that of the two legs of the hairpin projecting through the arch and held by the arch cover plate.

Probably the simplest form of atmosphere furnace is the bell annealer. As the term implies, it is a monolithic structure which can be suspended from the top and is usually handled by the service crane. These bells may be cylindrical for the smaller units but are more frequently rectangular for the larger capacities. Some installations have been made in steel mills of bell furnaces, having a work space of 4000 cu ft, which are capable of annealing a charge of 250 tons of steel coils. The heating elements for these bells or covers are usually mounted on the side walls and sometimes in between if the work is to be divided into rows, thus providing heat application between the rows. The charge itself is piled on a refractory-lined base and, when the bell is lowered over the charge, the bottom edge of its steel shell projects into a trough around the base where either fine sand or a liquid such as oil is used as a seal.

OPERATION OF BELL ANNEALER

The procedure of applying prepared atmospheres to bell furnaces is comparatively simple. The first step is to purge out the contained air with a sufficient flow of the atmosphere gas and to do so before the work rises sufficiently in temperature to be affected by some residual air. After purging, it is only necessary to flow such atmosphere as will take care of leakage, particularly where sand seals are used. For liquid seals, such as oil, the only necessity is to maintain slight pressure on the furnace after purging and during the heating-up and cooling-down cycles. If an inert atmosphere is used, such as prepared nitrogen, no additional steps need be taken, and no care is required in handling, since this atmosphere is noncarburizing, practically nondecarburizing, is noninflammable, and nonexplosive.

Metals in process of preparation are known to absorb considerable volumes of gases. At one time it was figured that the gases occluded within the untreated cylinder block of an automobile engine, if they could be extracted, would be sufficient to fuel the automobile for a distance of one mile.

Some of these gases are oxidizing and at low temperatures may tarnish the surface of the metal. It is not unusual, therefore, to use atmospheres which are capable of counteracting these gases, which implies that the atmosphere should be reducing and concomitantly flammable and even explosive. There

are then introduced hazards of handling calling for the exercise of great care and even introducing preventive measures. For instance, the work may have to be protected by an inner metal cover in which is contained the reducing atmosphere, while between this and the outer or heating cover, an inert atmosphere is maintained. After cooling, the inert atmosphere is introduced into the inner cover to purge out before lifting the cover and exposing the work. These extreme precautions need be taken only when the gases are very explosive. Some of the other reducing gases which contain a high percentage of nitrogen allow for greater latitude.

It must be apparent from the foregoing discussion that the application of these atmospheres to furnaces faces the constant problem of excluding air at all stages of the operation. With a batch furnace such as the bell annealer, the solution is fairly simple. Continuous furnaces, however, present many difficulties. It must be borne in mind that explosion is not the only hazard of air admixing with the prepared atmosphere. In many of these processes, the presence of a small percentage of water vapor may prove extremely deleterious. Consider the case of a high-carbon steel heated in a prepared nitrogen atmosphere which has been previously dried to a dew point of —40 F. Although this is not a perfectly dry gas, nevertheless, it is so considered for practical purposes since its percentage of water vapor is of the order 0.013 per cent, which is extremely low. This prepared atmosphere contains 1.2 per cent hydrogen. If air were to be allowed to admix with this atmosphere even in such small amounts as 1 volume to 100 volumes of the atmosphere, the oxygen so introduced would combine with part of the hydrogen sufficiently to raise the dew point to +30 F. This atmosphere would then become definitely decarburizing. The percentage of water vapor would now become 0.55 per cent or over 40 times as much as was contained in the prepared atmosphere.

The continuous furnace requires that work be constantly introduced and as constantly removed from the work chamber. In such case the furnace must be maintained constantly open at both the entrance and exit ends. Consider the case of a tube-normalizing furnace. Since these tubes are of appreciable length, the most suitable mechanism is the roller hearth. These tubes are full of air as they nose into the furnace entrance and must be purged. The usual procedure is to design the slot at the entrance and exit barely to clear the tube, and then to introduce into the furnace chamber sufficient volume of prepared atmosphere to create a positive pressure that will automatically purge the tubes as they progress inward. The larger the tube diameter the greater the volume of atmosphere required, and this increase is very nearly in proportion to the square of the diameter. This may appear a wasteful procedure but to date no better means have been found to apply prepared atmospheres to this operation. And precautions must be taken so to house these furnaces as to reduce as far as possible wind currents striking the open ends. The pressure maintained within the processing chamber is of the order of 0.01 in. water column, and it does not take much of a draft to upset the balance of the atmosphere in such cases.

Where high openings are necessary, due to the height of the work load, other means have to be employed. Noncombustible curtains, multiple drop chains, flap doors, and other such devices are resorted to and are effective up to heights of 8 to 10 in. Beyond this, the method must be altered to that of semicontinuous operation which permits the use of air locks or purge vestibules. On occasion, where it is possible alternately to open the charge and discharge closures, the vestibule may be dispensed with by using a flame curtain which screens the closure while the furnace door is open. This is effective only in some specialized cases. The most positive method is to purge effectively and to so time the purging as to be faster than the rate of heating of the work.

CONCLUSION

Summarizing, it may be said that the processing of metals in prepared atmospheres has made considerable strides since its introduction a mere decade ago. It has encompassed all phases of heat-treatment and just now is moving into the forging field. It has brought about many refinements in the art of heat-treating which have made it possible to move furnaces from the blacksmith shop to the machine shop and place them into the production line. One example may be cited of three atmosphere normalizers interspersed in tandem between nine cupping and drawing operations, the whole assembly stretching for a distance of 700 ft and all units operating in complete synchronism. Further progress doubtless will be made as time goes on and materials of construction are further improved that will provide the furnace designer with greater latitude in building for the future.

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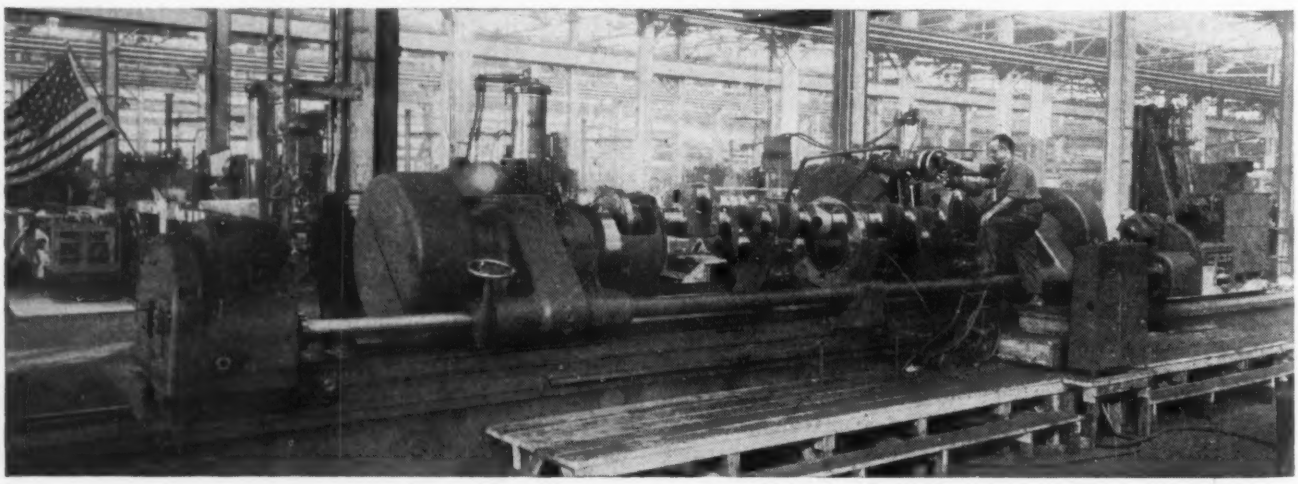

GRINDING A DIESEL-ENGINE CRANKSHAFT AT THE BALDWIN LOCOMOTIVE WORKS

WAGE INCENTIVES *Under* WARTIME CONDITIONS

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THERE have been times during this war when the tide has been turned in critical battles by the use of relatively small amounts of equipment of exactly the proper effectiveness. This was definitely true at the battle of Midway and at the epic moment when Rommel's tanks were stopped, destroyed, and turned back at El Alamein. The margins between success and failure were not great. American management and the man at the lathe have risen to the occasion until we no longer doubt the ultimate result.

Now, it is a matter of making our margins of critical supplies as great as possible to overwhelm the enemy in minimum time and with minimum bloodshed. Very recently Churchill stated:

"Unless some happier event occurs on which we have no right to count, then 1944 will see battles far larger and more costly than Waterloo or Gettysburg."

Surely management and labor cannot complacently take the position of being satisfied to coast along at the present rate of production, great as our achievements have been.

How can we alter this rate?

Frederick W. Taylor, Henry L. Gantt, and other members of The American Society of Mechanical Engineers gave one answer to this question over thirty years ago: "Scientific research into the methods of management and methods of operation, to the end that truth and facts be substituted for guesswork and opinion. Mr. Gantt[1] stated in 1916: "If we allow ourselves to be governed by opinion where it is possible to obtain facts, we shall lose in our competition with those who base their actions on fact."

This statement has never been more true or more important than at this moment. The expansion of our war-production facilities, the changing of models, specifications, methods, and materials has been tremendous. This has multiplied many times the factual data necessary to be obtained by a diminishing supply of industrial engineers. The management which will contribute most to increased war production as well as to the success of our industrial economy following the war is that management which will select and train the most competent individuals to gather the facts necessary to determine the best methods of operation of all members of the organization from top to bottom.

VALUE OF SCIENTIFIC OPERATION STANDARDS

There are two facts which have been clearly proved during the past few decades and are being demonstrated today:

1 Plants in which scientifically determined standards of operation have been maintained show a large increase in production per man-hour over plants which have grown up without such study. By altering conditions and practices which are under the control of management, such as improvement in design, equipment, material, and methods, it often occurs that the production of individual workers may be increased several hundred per cent. It is not unusual to see instances of 100 per cent increase in the per-man-hour productivity of a department or an entire plant.

2 A worker is usually willing and glad to respond with a considerably increased effort over his normal day-work effort when a reasonably attainable task or standard time allowance is established for a given operation with a suitable reward offered for the increased performance.

Where these two conditions exist, that is, where reasonable work assignments have been established based on a thorough substitution of fact for guesswork and where a proper reward has been offered, we have the maximum possibility of increased production. It goes without saying that clear understanding and good labor relations are necessary, but the proper use of demonstrable facts is bound in itself to make for such relations.

Unfortunately, over the past years there have been many instances where tasks and standards have been established without a thorough study and application of facts and without fixing management's responsibilities in setting up and maintaining correct conditions. Such situations resulted in the establishment of loose rates so easy of accomplishment that often workmen held back in their effort either through fear that by doing too much their rates would be changed or because they would otherwise earn an amount of money ridiculously large as compared with other workers. In other instances, rates which originally were satisfactory became either too tight or too loose because of changed conditions for which corrections were not made. Such conditions may well make for bad labor relations and for less production than a well-administered day-work plan.

There are all too few plants where wage-incentive systems are founded and maintained on a thoroughly engineered basis of facts and where these facts are understood and applied with complete co-operation between management and labor or labor's representatives. By establishing these conditions where they fail to exist, we could surely increase our national production with the same facilities and labor by at least 35 per cent. A substantial portion of our failure to obtain maximum productivity may be found in plants where incentives already exist. It may be due to lack of competently engineered methods or by lack of real co-operation between management and workers.

The potential increase in productivity in plants now on a day-work basis is indicated by the results already attained in the case of incentive plans approved by the War Labor Board during the last few months. Although we cannot be sure of the thoroughness with which the standards have been set, the reported results studied show an increase in productivity of 58 per cent in those cases where the standards were set on an individual basis by use of time study.

During the past year management and labor alike have been looking toward the wage incentive as a panacea for economic ills of all kinds. Wage-stabilization rulings have provided the chief motives for this trend. Many in labor see incentives as the only feasible way of securing higher earnings; many managements wish to make use of them either to hold their workers from migrating to other plants or to attract workers from elsewhere.

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[1] "Industrial Leadership," by H. L. Gantt, Yale Scientific Press, New Haven, Conn., 1916.

WAGE INCENTIVES FOR INCREASED PRODUCTION

The real motive for our present deep interest in wage incentives must be production and more production. Along with production comes the conservation of our diminishing supply of manpower. Again we must realize that with wages stabilized and threatening to rise we must depend upon increased production to meet our future competition and the problems of foreign trade.

In peacetime each industrial unit has had the opportunity either to build up its management methods on the rock of fact or allow itself to drift in the sands of guesswork. Each unit has had the opportunity to use an effectively engineered plan, a poorly conceived or neglected plan, or no incentive plan at all. Government has not and should not interfere.

So in wartime the same condition exists except for the restrictions which are imposed by the National War Labor Board in order to contend against inflationary abuse.

The National War Labor Board has stated that its consideration of wage-incentive cases will be limited to voluntary submissions by employers and to joint submissions agreed to by employers and unions in each situation in which a union is the collective-bargaining agency of the employees. It will not order a wage-incentive pay program in dispute cases since that would be incompatible with the need for co-operation.

The War Labor Board, moreover, has stated that its action will be limited to a determination of whether or not the proposed wage-incentive plan is in conformity with the national stabilization program. Those proposing a plan must assume full responsibility for the technical details.

This was certainly a correct decision, placing as it does the initiation and design of such a program directly within the plant. In every plant the technical background and the management-and-labor relations are different. The whole subject varies as human consciousness varies, with time and locality.

It is therefore fortunate that no government board has put forward a definite formula specifying what constitutes a proper incentive plan. With managements disagreeing radically with each other and unions disagreeing with each other as to the requisites of incentive plans, and even as to their desirability, it would be preposterous for government agencies to attempt to frame a rigid plan to inflict upon American management and labor.

Thus the main problem of industrial engineering and industrial relations is directly in the hands of industry. In order to make its most effective contribution toward winning the war and, at the same time, in order to protect its postwar existence:

1 Management should make use of the most capable members of its staffs as well as such competent consulting staffs as are available, to determine the facts that are the basis of the proper functions and work assignments of all employees from top to bottom. This should be done regardless of whether or not there is a wage-incentive plan.

2 Management should, where wage-incentive plans already exist, take every step possible to bring it in line with the best wage-incentive principles.

3 Where there is no wage-incentive plan, but where the necessary basic facts have been determined and where the labor relations are such as to insure understanding and co-operation, management should make every effort to effectuate a proper plan.

4 Management should, in critical war plants failing in vital production, give its best thought toward working out the plan which will be most apt to get immediate results and still allow for the future development of basic facts or standards.

Some have questioned whether we should endorse broad plans not laid out on a completely sound engineering basis, lest our postwar economy be thereby endangered. This is an important and serious viewpoint. Nevertheless, experience is making it clear that such plans are increasing the production of planes and fire power for which the armed services are crying out.

On the field of battle the best of engineering skill is used but all of the necessary facts cannot be obtained; neither are men and time available to do the job that would otherwise be done. The best possible estimates are made; the best practical bridges and defense are constructed, considering the time element.

So in the case of incentives, in plants from which we are desperately in need of production, we may need to pass over some of the technical details which in other times we would insist upon, and call upon management and labor to provide greater shares of leadership and co-operation. We should still use the ultimate of engineering knowledge but perhaps work to broader tolerances. Much care, of course, should be given to see that our correlation between effort and our measure of effort is positive and sufficient and that the reward is in reasonable proportion to this effort.

It is unfortunate, if in this process our industrial front must undergo some relatively slight sacrifices in industrial practice, but after all, our allies have sacrified thousands of industrial units and have destroyed many of their best bridges, dams, and utilities.

With care in engineering and care in labor relations, little will be lost and, in any case, the fundamental principles of honesty, understanding, truth, and square dealing need not be compromised.

MANAGEMENT CONSULTANT DIVISION OF THE WAR PRODUCTION BOARD

The War Production Board's interest in wage-incentive plans flows from its interest in increased war production. Over a thousand managements have applied to the Management Consultant Division for assistance. This assistance takes the form of engineering advice. There is no dictation, no exercise of authority, no veto power. There is no opportunity for extended service such as is given by consulting industrial engineers. Our policy is to work with managements on the plans they have initiated with the object of evolving the soundest methods possible consistent with the critical need of production, the time element involved, and the effect on the stabilization program.

The Management Consultant Division in collaboration with the Labor Production Office of the War Production Board assists the National and Regional War Labor Board at their request in evaluating proposals submitted to those offices with respect to their probable effect upon costs, wages, and production. Well over 500 cases have been handled in this manner.

GENERAL PRINCIPLES FORMULATED BY MANAGEMENT CONSULTANT DIVISION

We will now discuss general principles which the Management Consultant Division has formulated as applicable to most types of incentive plans.

1 A wage-incentive plan releases forces acting on two of the most potent factors in labor relations, wages and effort expended. Therefore in establishing such a plan all available scientific and engineering ability should be used, combined with a sympathetic attitude toward the human relations involved.

2 A wage-incentive plan may be a dynamic and constructive force for increased production, or it may be a means of disrupting labor relations and actually lowering production. Therefore management should realize that incentive plans must have the continued attention of top executives.

3 If a company's employees are represented by a recognized union, their representatives should be fully and continually informed regarding the methods and procedures used and the objectives to be accomplished. Management and the bargaining agency should be in real agreement as to the adoption or modification of the plan.

4 The plan should be sufficiently simple to be thoroughly understood by those to whom it is applied. Oversimplifica-

tion may involve injustices; attempts to meet every exigency, however, tend to overcomplicate. Workers should understand the effect of their own efforts on their earnings.

5 The plan should definitely increase production as well as wages.

6 There should be no appreciable increase in the unit labor cost of the operations performed by the workers to whom a plan is applied.

7 Production standards, where practicable, should be developed from detailed time studies. Clear and definite standards eliminate future difficulty and misunderstanding.

8 In general, the production standard should be established by management as the amount of work performed per unit of time by a normal qualified operator under normal conditions.

9 The plan should provide for the changing of production standards whenever changes in methods, material, equipment, or other controlling conditions are made in the operations represented by the standards. In order to avoid misunderstandings, the nature of such changes should be made clear to the union, which should have the opportunity to appeal through the grievance machinery.

10 The practice of setting a temporary standard in new plants or on new operations (because of the desires of both management and labor to have incentive work before the permanent standard can be set) should be kept to a minimum. It should in any event be clear to all that the standards are temporary and for a reasonably short period only.

11 Except for such changes as described in item 9, and for temporary rates, item 10, production standards once established should not be altered except by mutual agreement between the company and the representatives of its employees. When these representatives have sufficient confidence in the management to offer the correction of errors made by management in setting rates, and when they can convince the employees of the wisdom of this step in the interest of unrestricted production, this is an indication of advanced labor relations. Conversely, management should be willing to correct too severe rates.

12 Under ordinary circumstances management should guarantee that the employees' basic hourly rates which existed prior to the plan should become guaranteed rates of pay under the plan.

13 When production standards are properly set as outlined in items 7 and 8, good practice has demonstrated the desirability of adopting an incentive payment in which earnings above the established standard are in direct proportion to the increased production, that is, a 10 per cent increase in production over standard should call for 10 per cent increased pay over the base rate. This statement should not, however, be universally applied. Often in order to increase immediately critical production, managements and unions have agreed to use crudely estimated standards before production has been reasonably stabilized. If, in all such cases, payment above low standards were paid in direct proportion to production increase and not really accompanied by effort increases, instances of doubled and trebled earnings would arise and plague both labor and managements. Actual inflated increases would disturb intraplant and intracommunity wage levels. Potential increases might be more serious due to the tendency toward restricted production which would prevail. In order to guard against such a condition and still provide an incentive, managements and unions have often by agreement adopted a plan in which the reward of increased production is shared jointly.

14 In ordinary times and without the war motive, it is generally conceded that incentives applied to individuals and small groups are more responsive than those applied to large groups. When a plant is divided into a number of large groups on incentives, it often happens that feelings of injustice creep in, and plant transfers are difficult to effect. This, of course, is not true of plant-wide incentives.

15 It is often felt desirable to include indirect workers in the incentive plan, even when the measurement of their production is impracticable. If this is done and they are paid a bonus commensurate with the production of measured employees, the indirect man-hours should in some way be correlated to some measurable unit, such as total production or direct employee hours, so that indirect-labor overhead costs may be kept under control.

16 Today we need immediate increase in war production. There are plants where it is impractical from the point of view of time to wait for scientifically established individual standards. In many such cases all-over plant incentives may be devised which will prove effective during the war. Although in peacetime the dilution of the individual's effort might be so great as to indicate the probable ineffectiveness of this method, today it is essential to put every effort back of plant teamwork. There are clear indications that, with enthusiastic support of management and labor, standards may be set for an entire plant based on actual production per man-hour, and incentives paid to all employees as a proper reward for the extra effort and accomplishment.

RESULTS OF WAGE-INCENTIVE-PLAN ANALYSIS

The staff of the Management Consultant Division, because of its work with the War Labor Board and its interest in increased production, has been greatly interested to see the results of recently installed incentive plans. Accordingly, an analysis has been made of 234 cases which have been approved by the New York, Cleveland, Detroit, and Chicago Regional War Labor Boards. The following figures are based upon these 234 cases.

The total number of employees covered by the cases analyzed was 60,222. Individual cases ranged from as few as 6 employees to as many as 7500; by far the greater number falling into the 1 to 250 sized group.

In 47 per cent of the plants, the employees were represented by unions. C.I.O. unions accounted for 26 per cent, A.F.L. for 14 per cent, United Mine Workers for 1 per cent, and independents for 6 per cent.

Each plan was analyzed to determine whether the standards as set represented the productive effort of an individual, a group of employees within one department, or all of the employees of the plant; also whether it concerned a group of indirect employees only. Then these main groups, that is, individual, group, plant-wide, and indirect employees only, were broken down as to the manner in which production standards were developed. The results are shown in Table 1.

TABLE 1 RESULTS OF ANALYZING PLANT PRODUCTION

Number of cases	Type of plan		Per cent of total
98	Individual	Time study: 50 cases—51 per cent Past performance: 48 cases—49 per cent	41.9
96	Group	Time study: 17 cases—17.7 per cent Past performance: 78 cases—81.3 per cent Sales volume 1 case—1 per cent	41.0
36	Plant-wide	Time study: 2 cases—6 per cent Past performance: 25 cases—69 per cent Sales volume: 9 cases—25 per cent	15.4
4	Indirect	Past performance: 4 cases—100 per cent	1.7
234			100.0

A trend toward plant-wide plans is indicated by the fact that 15 per cent of the cases were of this type. It is interesting to note that this type of plan was not confined to multioperation

TABLE 2 DEVELOPMENT OF PRODUCTION STANDARDS

Method of developing standard	Per cent of total
Time study	29.5
Past performance	65.8
Ratio of labor cost to sales volume	4.7
	100.0

TABLE 3 RELATION BETWEEN STANDARDS AND PAST PERFORMANCE

Method of developing standards	Average per cent of increase at standard over previous productivity	
Time study	16.9	Individual, 17.8; Group, 10.8
Past-production performance	3.5	Individual, 5.3; Group, 2.2
Ratio of labor to sales volume	7.9	

TABLE 4 DISTRIBUTION OF INCENTIVE EARNINGS

	Relation between increased earnings and increased production	
Method of developing standards	Per cent of cases providing 100 per cent	Per cent of cases providing less than 100 per cent
Time study	85.5	14.5
Past performance	63.6	36.4
Sales volume	45.5	54.5

plants where it generally is a difficult and lengthy task to develop operational standards. Several cases involving a small number of operations and only a few employees used the plant-wide plan.

Each case was examined regarding the manner in which production standards were developed; whether by actual time study of each operation, by records of past performance, as measured in units of production, or by establishing a ratio of labor cost to volume of sales, as shown in Table 2.

Perhaps the most interesting finding was the use of means other than time study to develop production standards. It is our definite feeling that standards based in any manner upon sales volume should be used only when production is critically needed, and then the relationship between effort and a measure of sales volume should show a close correlation.

We also determined the relation between the standards and past performance, that is, the extent to which production must be increased before incentive payments would be made to employees. In other words, it is the margin between past performance and the amount of production required exactly to equal standard. The results are indicated in Table 3.

It will be noted that standards developed from time studies were set 16.9 per cent in excess of previous production. On the other hand, standards developed from past performance were set almost at past performance, and where a ratio of labor cost to sales volume was used as a standard, the figure was only slightly in excess of previously attained performance.

The distribution of incentive earnings resulting from production in excess of the standard is shown in Table 4.

The split of earnings above the established standard followed a well-developed pattern. In the majority of cases using standards developed from time study, incentive earnings were distributed in direct proportion to the increase in production above standard. In cases where standards of past performance or sales volume were used, the percentage of cases providing 100 per cent distribution to employees was considerably less.

Figures are given in Table 5 on 49 cases taken from the four regions which were reported to us by managements. These figures represent production increases since the approval and application of the wage-incentive plan. The period of time is a short one since most of the plans have been in operation 2 months or less.

Using these figures, unweighed by number of employees, the average increase in production above standard was 27.9 per cent. The average increase in production above past performance was 41.5 per cent. Its range was from 0 to 103 per cent grouped as in Table 6.

TABLE 5 PRODUCTION INCREASE SINCE APPLICATION OF WAGE-INCENTIVE PLAN

Product	Type of plan	Method of setting standard	Per cent of increase in production above standard	Per cent of increase in production above past performance
Electronic tubes	Individual	Time study	30	63
Aircraft parts	Individual	Time study	15	73
Stop-nuts	Individual	Time study	11	24
Plastics	Individual	Time study	20	44
Steel products	Individual	Time study	55	86
Aircraft equipment	Individual	Time study	24	47
Life belts, rubber boats	Individual	Time study	27	32
Baling presses	Individual	Time study	14	83
Aircraft bearings	Individual	Time study	13	41
Tank treads	Individual	Time study	11	40
Machine tools	Individual	Time study	64	64
Metal products	Individual	Time study	65	103
Parts for chemical warfare	Individual	Past performance	20	42
Electric connectors	Individual	Past performance	35	55
Die castings	Individual	Past performance	30	53
Piston rings	Individual	Past performance	15	27
Aircraft instruments	Group	Time study	8	14
Parachutes	Group	Time study	15	33
Photographic equipment	Group	Time study	16	54
Aircraft pressure fittings	Group	Time study	11	32
Aircraft tank motors	Group	Time study	0	0
Canned foods	Group	Time study	10	10
Power transmissions	Group	Time study	27	41
Aircraft instruments	Group	Past performance	98	98
Paper bags	Group	Past performance	11	11
Textiles	Group	Past performance	15	15
Ammunition containers	Group	Past performance	16	16
Castings	Group	Past performance	17	17
Foundry supplies	Group	Past performance	33	33
Ceramics	Group	Past performance	17	17
Armor plate	Group	Past performance	20	21
Navy blankets	Group	Past performance	30	30
Confidential maps for Signal Corps	Group	Past performance	9	38
Blueprint paper	Group	Past performance	3	3
Cartridge clips	Group	Past performance	10	10
Heating equipment	Group	Past performance	42	66
Truck bodies	Group	Past performance	70	70
Canned meat	Group	Past performance	50	50
Radio equipment	Group	Past performance	35	35
Air filters	Group	Past performance	20	20
Aluminum castings	Group	Past performance	13	13
Metal salvage	Plant-wide	Time study	100	100
Lubricating oils	Plant-wide	Past performance	66	83
Lathes	Plant-wide	Past performance	59	75
Parachutes	Plant-wide	Past performance	15	15
Rug cushions for aircraft	Plant-wide	Past performance	15	15
Precision optics	Plant-wide	Sales	38	58
Grinding wheels	Plant-wide	Sales	21	54
Paper containers	Indirect Employees	Past performance	10	10

Table 7 shows the averages (based on these 49 cases) of per cent increase in production over past performance for various types of plans with standards based on different measurements.

(*Continued on page 120*)

CONSERVATION *in the* ORDNANCE DEPARTMENT *of the* ARMY SERVICE FORCES

By THORNTON LEWIS

DEPUTY CHIEF, PRODUCTION SERVICE BRANCH

THE outbreak of war in Europe brought the United States face to face with a production problem and a consequent demand for materials which exceeded in magnitude any such need ever before experienced in the history of the world. The first rush to meet the emergency of sudden war permitted little time for redesign or economies in materials or machines. Soon, however, the suppliers of materials began to feel the strain of huge demands, and the need for conservation became not only apparent but of paramount importance.

The Ordnance Department of the United States Army Service Forces is directly responsible for the development, design, procurement, supply, and maintenance of all weapons, ammunition, tanks, and combat and transport vehicles used by the Army and supplied to our Allies through Lend-Lease.

In substituting, converting, or downgrading materials entering into any of this equipment, great care must be exercised to the end that the characteristics and quality be not sacrificed, as the safety of our soldiers and performance in the field are involved. Therefore no design change can be approved until its effect is positively known. This situation could be used as an excuse to retard or prevent conservation, but such has not been the attitude of the Ordnance Department.

In no branch of the government was the need for conservation more keenly appreciated than in the Ordnance Department, for its demands for raw materials to meet its program exceeded that of any other service responsible for production for war. The situation called for action, and action was taken.

A Conservation Branch was established in the Technical Division, whose function it was to implement conservation policies in new designs. A Suggestion and Conversion Section was created in the Industrial Division, whose duty it was to effect conservation in existing designs already in production. This latter conversion effort was to be accomplished from changes initiated by the personnel of the Conversion Section itself and by means of suggestions received from engineers in industry. Similarly, conversion engineering sections were established in each of the Ordnance Department's thirteen district offices. In functioning through these thirteen field offices as well as in headquarters in Washington, the Ordnance Department conservation organization is unique among the armed forces, and to this field contact we attribute much of our success.

Thus, the problem of conservation was tackled from two angles: first, *new* Ordnance designs and, second, the much greater field of Ordnance matériel already being manufactured. The problem was so large it was realized that the Army alone could not do the whole job, but by means of a promotional campaign, the brains and ingenuity of engineers in private industry were mobilized.

This program was initiated by Maj. Gen. L. H. Campbell, Jr., Chief of the Ordnance Department, and has had the enthusiastic support and assistance of Gen. G. M. Barnes, chief of the Technical Division, Maj. Gen. T. J. Hayes, chief of the Industrial Division, and Brig. Gen. H. F. Safford, chief of the Production Service Branch, under whom the Conversion Section was established. To further this work, three booklets were published and distributed throughout industry generally. These were called "Tremendous Trifles," "Metallurgency," and "Battlenecks," and are still available for distribution upon request. In these booklets many examples are described and illustrated so as to stimulate further thought and suggestions.

From the United States Army Ordnance Department's program, truly remarkable results have accrued.

American (and I use that word in its broad sense) engineers have never failed to improve a product no matter how good it was when they started to work on it. To an American a good record is only a challenge to make a better one, even though he may be proud of the one already achieved. The progress of our conservation program has proved this true. If our specifications had remained as they were before the war, we would have reached our production ceiling long ago. The fact that stock piles of scarce materials are not completely exhausted, and that production has moved ahead steadily proves that conservation has reached tremendous proportions. In fact, there seems to be no end to the possibilities of conversion engineering. The only limits we have met with are *time* and the *number* of competent engineers who are available to work on the existing problems.

As so often happens when a development is undertaken to secure a specific saving, other benefits are also realized. This has been the experience in our Conversion Engineering Program. When a conversion study was finally completed, not only was a saving in critical materials accomplished but in most cases there was also a reduction of machine hours and over-all cost. In many instances fewer critical machine tools were also required.

Some few illustrations may be in order. It was found that fragmentation bombs were doubly effective and safe to use if dropped at low altitudes by parachutes. Present procurement created a demand for over 44 million yards of parachute cloth which, in the past, had been made from high-tenacity rayon 36 in. wide. This rayon was no longer available because it was required for war-vehicle tires. Here we literally "cut the chutes to fit the cloth." Semi-high-tenacity rayon was substituted and the width changed from 36 in. to 28 in. This change eliminated all waste. Over 12 million square yards of this critical material were saved, and over 13 million pounds of high-tension rayon made available for military tires.

The shipping band for 250-lb bombs was formerly made with two circular steel strips formed into U-shaped sections, each weighing five pounds. These have now been replaced by laminated impregnated paper bands secured by a light steel strip. On the next million bombs shipped, this idea saved more than nine million pounds of steel. This design has now been adopted on the 500-lb and 1000-lb bombs with even greater unit savings.

The new mechanical solderless method of crimping windshields on armor-piercing shot not only has proved superior, but will save 1,873,000 lb of solder on the production, in the last seven months of 1943, of shot ranging in size from 37 mm to 3

in. Most important, however, is that slightly more than half of this weight is bismuth, which is vitally needed in pharmaceuticals for medical treatment. Bismuth has become increasingly critical as production for war has advanced.

Plastics have replaced critical nonferrous metals for many uses. In 1943 we shall use more than 8,250,000 lb of resin.

The cases cited were selected because they illustrate the use or conservation of materials other than the ordinary metals. Of course, our greatest savings were accomplished in the nonferrous and ferrous group of metals. Particularly is this true where carbon and low-alloy steels were substituted for the high-alloy steels. In some cases carbon and low-alloy steels with special heat-treatment were found capable of meeting Ordnance requirements and thus they could be substituted for high-alloy steels.

In many more cases great savings were obtained by substituting steel stampings for components made from machined bar stock or forged steel. The cold-working of the metal in stampings made it possible to secure many parts with sufficiently high physical properties to meet the most rigid tests.

These substitutions not only saved critical materials but allowed, in many instances, an enormous increase of production.

Modern industry has for years used metal-forming and stamping machines where mass production was desired, and thus the presses and stamping machines were available ready for use. On the other hand, early delivery of metal-cutting and turning machines such as lathes, broaches, and automatics was impossible to obtain. The demand for many critical production tools was eliminated, idle machines were put to work, and 44,000 tons of steel alone have been saved, on 1943 production, through the introduction of steel stampings.

A case of conservation, in which two separate Army services have co-operated, recently came to my attention. In making air-field landing mats from S.A.E. 1010 steel plate, holes are punched, creating millions of 10-gage disks approximately $2^1/_4$ in. in diameter. Formerly the Engineer Corps sent these disks back to the steel mills as scrap. The Ordnance Department has found a half-dozen uses for these disks in the manufacture of ammunition components. Even these uses will not completely consume the entire supply, but we shall continue our search to find additional places where these disks may be employed.

At the beginning of the war emergency a great deal of foundry capacity in the United States was idle or was made idle by the demand for war goods that did not include either malleable or gray-iron castings. Through our conversion work we have increased the use of malleable-iron castings 80 per cent, and gray-iron castings 50 per cent. Die castings of metals other than iron or steel offered opportunities and we have increased the use of these castings 60 per cent. Powdered metal has also been explored and our 1943 production will include 11,000,000 lb of iron and brass powdered-metal components.

For many purposes we have experimented with wood as a substitute for metal. On one type of work substantial results have been secured. This is in the manufacture of truck and trailer bodies. On each $2^1/_2$-ton truck more than 1000 lb of steel will be saved. On the $1^1/_2$-ton truck, more than 700 lb, and on the 1-ton cargo 2-wheel trailer, more than 300 lb of metal will be conserved. These savings bulk very large, as more than 100,000 of each of these vehicles will be produced in 1944.

The conservation program has been sufficiently successful so that today our raw materials and production machines are no longer the most critical factors among the elements making up production. The most critical factor is manpower. The scarcity of labor which now exists and which threatens to exist in the next six months in the United States may be the most serious problem which has yet been presented to our country. In this field there is great need for conservation and much can be done in more efficiently using the manpower that exists. Certainly this presents a challenge to our best abilities.

Savings of the following critical materials, based on 1943 procurement, will be effected by the Ordnance Department Conservation Program:

Aluminum	Enough to build 25,000 fighter planes
Copper	Over 200,000 tons
Crude rubber	Over 115,000 tons
Steel	Over 622,000 tons
Zinc	Over 100,000,000 pounds
Nickel	Over 50,000,000 pounds
Molybdenum	Over 5,000,000 pounds
Chromium	Over 12,000,000 pounds
Tin	Over 5,200,000 pounds
Tungsten	Over 9,000,000 pounds

Our constant aim has been to downgrade from critical materials to materials less critical and therefore easier to obtain.

Suggestions received by our Conversion Sections in 13 months exceed 3300. About 800 have not yet been acted upon, 1200 have been rejected, and more than 1300 accepted for production. More than 50 per cent of all suggestions considered have been adopted. This high percentage is a tribute to the fine intelligence and ingenuity of the industrial engineers who have co-operated with the Ordnance Department in this program.

Just as our field forces have learned to outfight the Axis and beat them at their own game, so our engineers, designers, and manufacturers are outthinking our enemies in the business of creating more and better engines of destruction from our limited supplies of critical materials. We confidently expect the engineers of the United Nations to continue with their efficient conservation efforts until victory is won.

Wage Incentives, Wartime Conditions

(*Continued from page 118*)

TABLE 6 AVERAGE INCREASE IN PRODUCTION ABOVE PAST PERFORMANCE

Range in per cent of increase in production above past performance	Number of cases
0– 20	15
21– 40	11
41– 60	11
61– 80	6
81–100	5
Over 100	1

TABLE 7 AVERAGE INCREASE IN PRODUCTION OF VARIOUS PLANS

Type of plan	Method of setting standard	Per cent of increase in production above past performance	Number of cases
Individual	Time study	58.2	12
Individual	Past performance	44.2	4
Group	Time study	26.4	7
Group	Past performance	31.2	18
Plant-wide	Time study	100.0	1
Plant-wide	Past performance	46.8	4
Plant-wide	Sales	55.6	2
Indirect employee	Past performance	10.0	1

In considering these data, our general conclusion is that a much more thorough engineering job is to be desired. This is emphasized particularly by the fact that only 21 per cent of the plans reviewed are of the individual type, based on time study, and by the numerous instances of small increases in production at standard over past performance.

However, we may be assured of no increase in unit labor cost, and clearly there are occurring heavy increases in production of vital war material which would otherwise have been delayed.

In proceeding with this problem each of us in this Society, each of us as engineers; each of us, whether in management, labor, or government, should bend our every effort toward taking the mysticism, misunderstandings, and injustices out of present and proposed wage-incentive systems to the end that facts be substituted for guesswork.

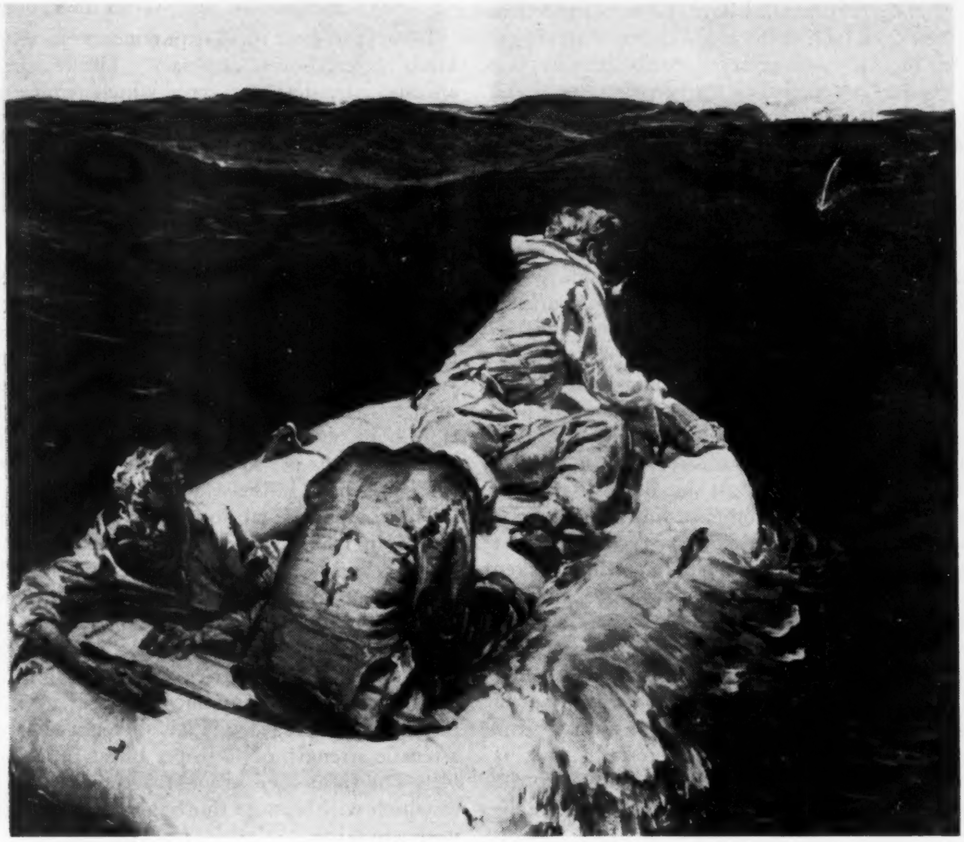

FIG. 1 INFLATABLE LIFESAVING RAFTS IN THE WAR EFFORT

Inflatable LIFESAVING RAFTS *in the* WAR EFFORT

By J. G. KREYER

THE FIRESTONE TIRE & RUBBER COMPANY, AKRON, OHIO

ONE of the most noble activities in our present national struggle is the earnest purpose and constant endeavor to provide better and improved means of saving the lives of our brave men who are exposed to the hazards of modern combat. Among such devices as made by the rubber industry are bullet-sealing fuel cells, barrage balloons, various types of life belts and vests, and gas masks. One of the more ingenious products is the modern pneumatic-type life raft and other similar devices used on all combat and transport vessels and airplanes of the Army and Navy. In providing this means of self-preservation in the vastness of the seas, the rubber industry has made an outstanding contribution to the war effort.

Forced to abandon ship at sea, or plane over water, it must be of greatest solace for one to know that there has been provided a means of flotation and a relatively safe haven with sustenance, water, first aid, and other necessities of life, until rescue comes. Only those who have been placed in the position of having to use the inflatable life raft can know the importance and effectiveness of this equipment.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

DEVELOPMENT OF THE PNEUMATIC LIFE RAFT

The achievement of the modern pneumatic raft did not derive from the present need, but rather is a development started many years ago. In fact, it might be considered an evolution since the history of rafts in lifesaving was born with the utilization of a piece of floating debris by persons shipwrecked many years ago, and from which evolved the wooden raft. The outgrowth of the inflatable life raft, however, is in direct connection with free ballons. About the time when these big bags stirred much interest in national and international racing, the idea was born and developed. The principle of confining gas or air in a tube for flotation purposes, which gives a combination of lightness, strength, and excellent gas or air-holding qualities, was made possible through the adaptation of the specially designed and processed fabrics that are used in balloons and other lighter-than-air craft.

Particularly adaptable for airplane use, this idea was gradually developed from just a tube, to the present shape of the

accepted lines of a boat with upturned bow and stern, and then the later refinements added such as the use of carbon-dioxide gas for rapid inflation, the inclusion of seats, oarlocks, oars, life lines, mast holder, sail, weather cloths, repair kits, hand pumps, emergency rations, signaling equipment, first-aid kit, and other appliances to complete the modern life raft as we know it today.

This development is an actuality mainly through the foresight and efforts of the designers of the accessory equipment of airplanes and operating personnel in the air-service divisions of our Army and Navy. The rubber industry has played an important part in this effort in the research, development, and processing of materials, as well as in the technique of manufacture.

The usefulness of the modern pneumatic life raft lies in its lightness, compactness, mobility, durability, and reliability. Lightness, because as in all airplane development weight is of prime consideration. Compactness, because space is usually limited. Mobility, because there must be flexibility so as quickly to conform from a thing of compact dimensions to one of maximum space and capacity. Durability, because it must endure, first in resistance to the effects of folding when packed in carrying cases for long periods of time under varying conditions of temperature, and then in confining gas or air under pressure without appreciable loss, and to provide the necessary strength and resistance to wear and tear encountered under actual use. Reliability, because the raft and its mechanism must function as designed, without failure in any way. The pneumatic raft has proved itself in all these respects and, as evidence of the performance of this equipment, we refer to the numerous rescues at sea about which much has been publicized.

Basically, the design of the pneumatic life rafts used by the Army and Navy is the same. The sizes and types employed by the two branches of the services differ only as is necessary to fit their particular needs. To all intents and purposes, the matter of size resolves itself down to the dimensions and capacity needed for a given number of persons; and the several varied types usually mean the use of special equipment for special service. Essentially, therefore, there are in use 1-man, 2-man, 4-man, 5-man, and 7-man rafts; each size for a particular use, but broadly speaking, provisions made suitable for the number of personnel carried in each type of plane. Therefore this discussion deals with the subject in a composite manner, emphasizing the basic principles and calling attention to the various phases by reference to typical features of design and arrangement. In Fig. 3 are shown the 1-man, the 5-man, and the 7-man to give a comparison of their sizes.

Table 1 is presented to show the dimensions and weights of the different capacities of rafts, as well as to bring out two of the important characteristics of design. (1) Note the vast difference in the dimensions of the rafts as packed in carrying cases versus the dimensions of the inflated raft ready for use. The ratio of volume or space required is approximately 15 to 1. (2) Note the weights of the rafts as compared to the rating or capacity. On the average, the rafts are capable of carrying approximately 100 lb for each 5 lb of material used in their construction.

TABLE 1 COMPARISON OF DIMENSIONS AND WEIGHT OF RAFTS

	Inflated Dimensions			Packed Dimensions		Weight of raft		
Rating	Length	Width	Tube diameter	Length	Diameter	Raft only	Plus equipment furnished by manufacturer	Plus equipment furnished by government
1-Man	5 ft 6 in.	3 ft 4 in.	12 to 7 in.	15 in. × 14 in. × $3^{3}/_{4}$ in.		$5^{3}/_{4}$ lb	16 lb	....
2-Man	7 ft 6 in.	4 ft 0 in.	13 in.	2 ft 6 in.	12 in.	22 lb	40 lb	$53^{1}/_{2}$ lb
4-Man	9 ft 3 in.	5 ft 0 in.	15 in.	2 ft 10 in.	14 in.	$36^{1}/_{2}$ lb	57 lb	79 lb
7-Man	12 ft 0 in.	5 ft 3 in.	16 in.	3 ft 0 in.	15 in.	$47^{1}/_{2}$ lb	77 lb	$111^{1}/_{2}$ lb

SPECIAL COTTON FABRICS DEVELOPED

In order to meet these requirements, an artful balance of combined materials was necessary. The cotton fabrics in use are an especially designed type, which require special machinery for their manufacture. The foremost requirements in their design are maximum strength and resistance to tear, with minimum weight, plus their adaptability to the coating in providing good gas- and air-holding properties.

The fabric used in the outside ply of the main-tube processed fabric is a material of special development which was originated with the envelopes of lighter-than-air craft and later adapted to use in rafts. This is a cotton fabric of a basket-weave construction and is especially designed for high tear resistance with minimum weight. It is constructed of plied yarns of long-staple combed cotton with five ends each in the warp and fill, and thus woven into the basket-weave construction. The material is preshrunk. The specified weight of this fabric is 5.6 oz per sq yd, with a tensile strength of 120 lb per linear in., both in the warp and in the fill.

The companion fabric used in conjunction with the basket weave in making up the main-tube fabric is called "plain weave" and is also a special development. This fabric is constructed of long-staple combed cotton, and is made into single yarns and woven into a construction of 120 × 120 yarns per in. The plain weave gives a smooth finish and the construction makes it particularly adaptable for coating where low permeability requirements are set up. This cloth is also preshrunk and singed, and has a weight of 2.1 oz per sq yd, with a tensile strength of 40 lb per linear in. in both the warp and fill. The tapes used in making the seams of rafts, the subject of which will be more thoroughly covered later, are also made with this fabric.

As an alternate to the basket-weave fabric, but which is now specified or to be specified by both the Army and Navy, is a fabric of an especially designed construction for maximum strength and tear resistance, coupled with low weight. This fabric is a closely woven fabric constructed of long-staple combed cotton made into plied yarns and with a weave known in the trade as "5 harness," i.e., the weave of the fabric is such that the yarns go over 4 and under 1, and this weaving is stepped off so the high tear-resistant quality is provided. This fabric has a weight of 6.8 oz per sq yd and a tear resistance of 135 lb per in. in both warp and fill.

The other fabrics generally used in the construction of life rafts are the square-woven ducks which are utilized for the bottoms, carrying cases, and pockets. This type fabric is used because these are not gas- or air-holding parts and therefore a heavier, rugged, and less costly material can be used. For this purpose, ducks of weights up to 18.5 oz per sq yd are used.

Up to the present, only cotton fabrics have been used in regular production rafts, but much work and investigation has been done in an attempt to utilize synthetic materials. Nylon and rayons have been processed and laboratory-tested and later made into actual products and service-tested. While the synthetic fabrics provide certain features of advantage, particularly that of lightness combined with strength, there have been found other objections or reasons for not using them in the construction of inflatable products. It is the opinion that, so

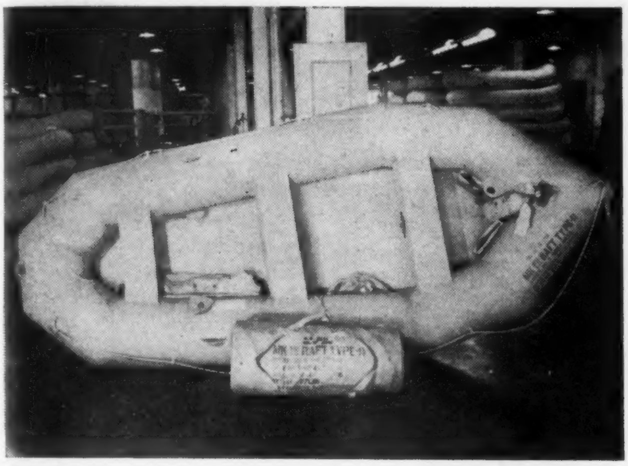

FIG. 2 COMPARISON OF PACKED AND INFLATED RAFT INDICATES ITS LIGHTNESS AND COMPACTNESS

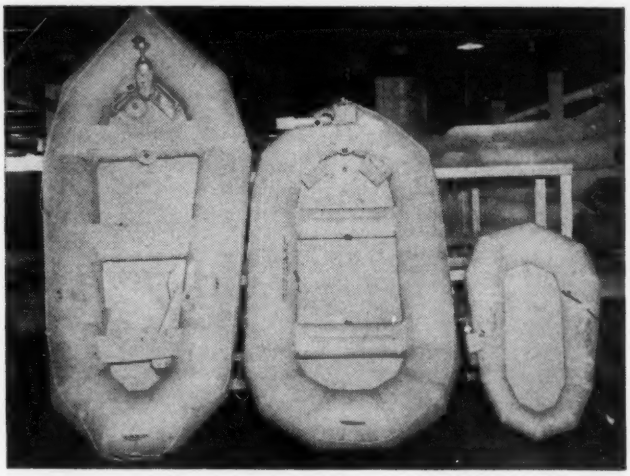

FIG. 3 COMPARATIVE SIZE OF 1-MAN, 5-MAN, AND 7-MAN RAFTS

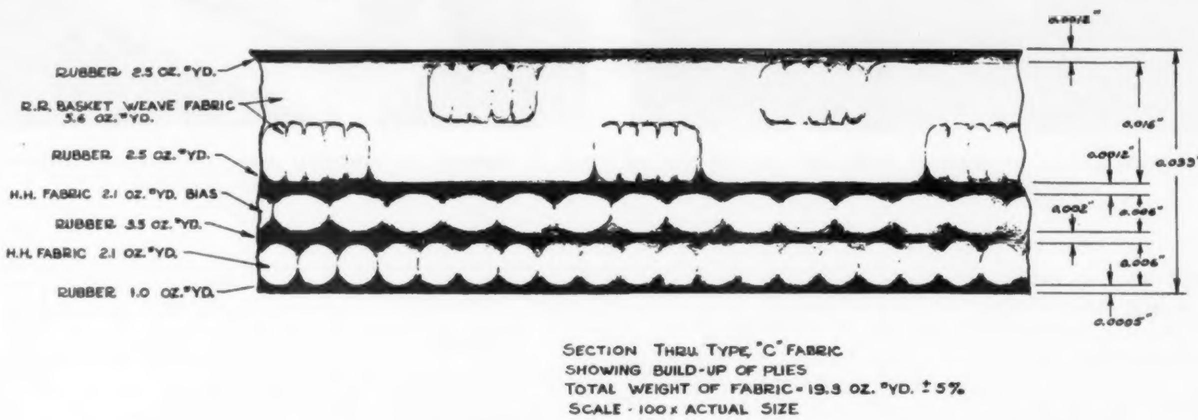

FIG. 4 DIAGRAM SHOWING LAMINATED CONSTRUCTION OF PROCESSED FABRIC USED IN LIFE RAFTS

long as sufficient cotton fabrics are available, this material will continue to be used, leaving the nylons and other strategic materials to be utilized in products where their usefulness is more adept.

In order to indicate the exactitude with which it is necessary to process coated fabrics for gas- and air-holding qualities, we show in Fig. 4 the cross section of one of the fabrics used in the main tubes of the larger rafts. This material consists of an outside coating of $2^1/_2$ oz per sq yd, which is of the basket-weave fabric. Next, on the underside of the basket-weave fabric, there is another coating of $2^1/_2$ oz per sq yd. Light-weight plain-weave fabric is then placed on a bias and then a coating of $3^1/_2$ oz per sq yd with another ply of plain-weave fabric, placed on straight, and an inside coating of 1 oz per sq yd completes this material for a total gage of 0.033 in. and a nominal weight of 19.3 oz per sq yd. Combined as shown, this material provides maximum strength, tear resistance, and gas- and air-holding qualities for a relatively low square-yard weight.

In the placement of one ply of these fabrics in a bias direction in order to increase tear resistance, this requires that both right- and left-hand fabric be provided. Right- and left-hand biases are used in alternate panels of the main tubes of the raft to offset the unequal torsional strains and movement that are imposed on the two-directional fabrics when the raft is inflated. This is done so the raft will not distort.

This material is typical of the exactness of design and processing of all fabrics used in the making of life rafts. Various combinations of the types and number of plies of fabric are used in other processed fabrics, depending upon the required strength and weight, for the different sizes of rafts.

COATING THE FABRICS

In the coating material for these fabrics, until recently, we have been fortunate in being permitted to use natural rubber, and the compounds have utilized up to 80 per cent by weight of this critical material. As with all lines of rubber products, the War Production Board reduced the amounts of natural rubber permissible and finally, in most of the inflatable products, directed the use of synthetic rubbers only. The immediate move to synthetic rubber in life rafts, however, has been discouraged because of the obvious need for service testing over long periods of time under packed conditions. Because the useful life of a raft represents a very small percentage of the total service time involved, it is important to determine what type or combination of types of synthetic rubbers will best retain the necessary qualities equal to those standards already established by natural rubber.

In the preparation of the processed fabrics, the mixing of the coating compounds for this purpose requires a dye which will give an inherent orange-yellow color. With the inherent color, in the use of natural rubber, this did not present any problem because of the absorption of the dye and the fastness of this color over long periods of time when exposed to sunlight. This particular color is required in life rafts in order to provide easy visibility in the water. In the use of synthetics, it is found that while an inherent color can be provided, when subjected to sunlight there is more or less discoloration caused by the antioxidant that is a necessary part of this synthetic rubber itself, so that after a short period of time there is no longer the sharp yellow shade, but there remains only a brown shade which becomes darker as time goes on. For this reason, there is now a demand for the development of a paint which will

FIG. 5 MANY LAYERS OF COATING MATERIAL ARE APPLIED TO FABRICS ON SPREADING MACHINES

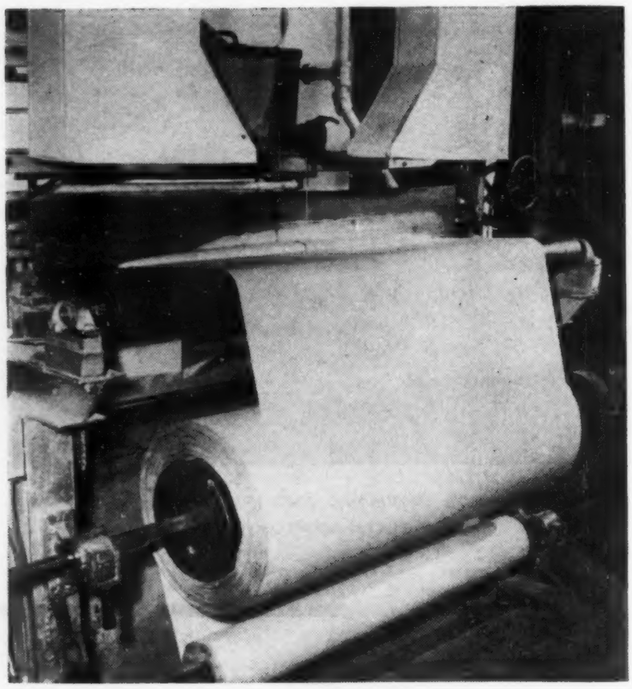

FIG. 6 METHOD OF APPLYING AND CONTROLLING AMOUNT OF COATING IN EACH LAMINATION

have the necessary qualities of flexibility, adhesiveness, fastness to color, and utilization in conjunction with synthetics.

Whether natural- or synthetic-rubber compounds, these are put into solution as cement and applied to the fabric on a spreader, in a laminated construction, requiring many coats or spreads. The Government specifications require that the compound shall be applied with a spreader, using not less than 8 spreads or coats per ounce per square yard of surface covered. For example, in the construction of the main-tube fabric, previously described, there is a total coating per square yard amounting to 9.5 oz. From this it can be seen that the required number of spreads or coats, according to the government specification, is 76. In other words, starting with 3 plies of fabric which has a total weight of 9.8 oz per sq yd, in order to arrive at the finished total weight per square yard of 19.3 oz, there must be applied 9.5 oz per sq yd of compound to these plies in the specified distribution. This means that the rolls are un-

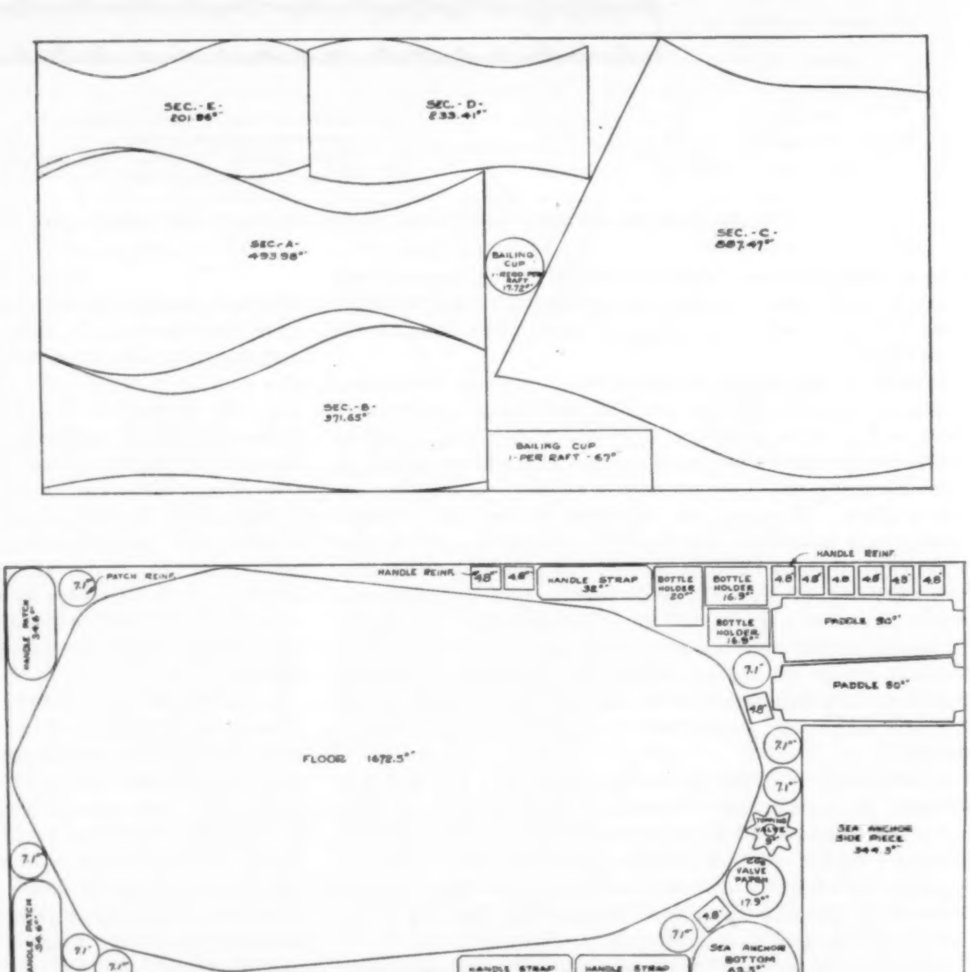

FIG. 7 MULTITUDINOUS SHAPES OF FABRIC WHEN ASSEMBLED MAKE THE MODERN LIFE RAFT

wound, spread, dried, rerolled, and then that process repeated 76 times.

Fig. 6 shows a close-up view of the spreader "knife" which is adjusted to apply the correct amount of coating on the fabric as it is passed through the machine. A "bank" of the coating material can be seen in front of the knife and the supply stream which maintains the correct amount of the material in the bank.

After the preparation of these fabrics on the spreader machine, they are rolled under tension on a curing drum, in treated liners, and are subjected to vulcanization under steam pressure. Each roll of fabric must meet Government specifications from the standpoint of gage, weight per square yard, tensile strength, permeability, and color. For this purpose, samples are taken from each roll for laboratory check tests on these requirements.

All this multiplicity of operation, offhand, seems superfluous, but when the desired and necessary qualities of a finished piece of material are considered, it can be appreciated that this combination of design, construction, and coating application is necessary.

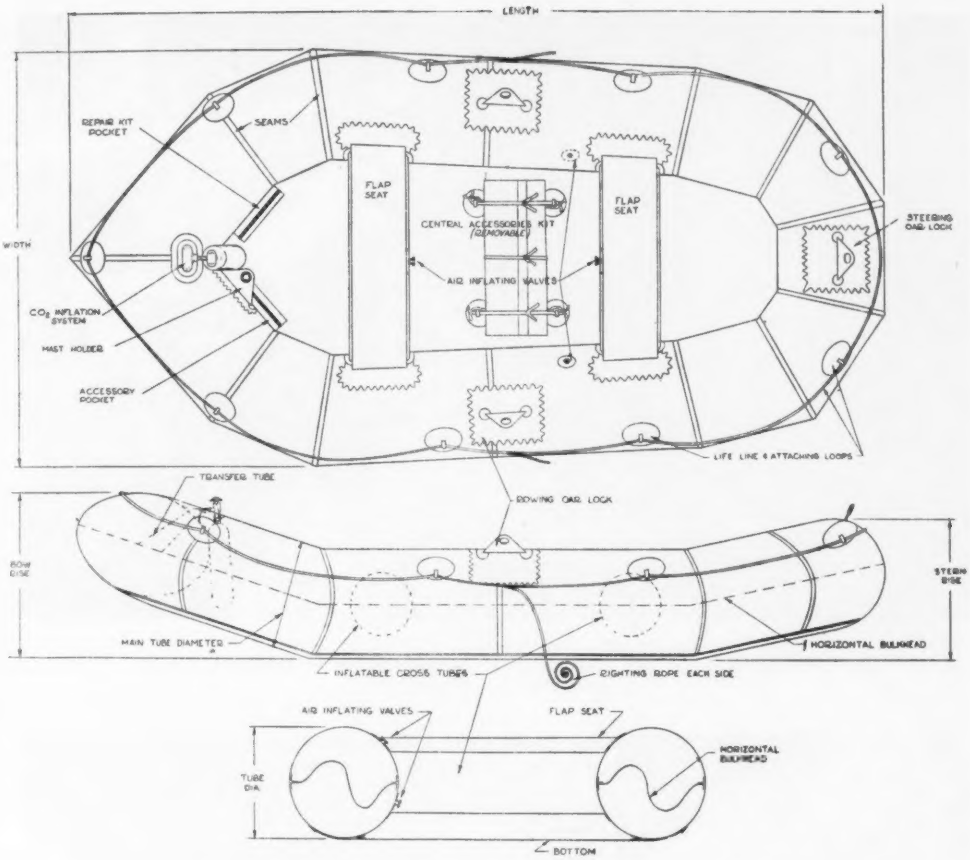

FIG. 8 TYPICAL ARRANGEMENT OF MODERN LIFE RAFT

DESIGN AND CONSTRUCTION OF RAFTS

In designing the raft, the general construction, dimensional features, and types and grades of materials are governed by specifications. Calculations of volumes to provide sufficient buoyancy are determined, after which layouts of the tubes or cylinders are made. From these data, the shapes and dimensions of the panels and pieces are determined. In turn these are laid out to determine the most economical arrangement for cutting of the fabric, as shown in Fig. 7. All of these pieces, when seamed together in their proper relation to one another, will give the desired shape and arrangement of parts.

In Fig. 8 is shown a typical design and arrangement of the modern life raft. This is somewhat a composite of the large rafts as used by both the Army and Navy Air Forces, but serves to show the basic design and arrangements common to all inflatable life rafts. Here can be seen the general shape in the plan, elevation, and cross-sectional views, and the placement of the various auxiliary parts.

The supporting or main buoyancy tube is divided into two compartments by a horizontal bulkhead. This bulkhead is made of lightweight two-ply coated fabric. It extends completely around the main tube and is attached to the inside of the tube along the horizontal diameter. The width of the bulkhead is equal to the semicircumference of the inflated tube so that the boat shape of the raft is maintained when only one compartment is inflated. This feature of design is for safety reasons and maintains buoyancy should the top or bottom half of the main tube be punctured or snagged. Each compartment of the tube is equipped with a valve for supplementary inflation, which is accomplished with the use of a hand pump fitted to this valve.

The color of the raft in all parts as viewed from above is a specified yellow, while the bottom is of a specified light-blue shade. These colors are used because of the better visibility of yellow on the water which facilitates rescue work, and the blue color on the bottom has less attraction for large fish, such as sharks, which in some waters harass the occupants continually.

Seats are made of the same fabric as the main tube and are attached to the inboard side of the tube as shown. The seats are inflatable through valves provided by means of a hand pump and are separate compartments not connected to the main-tube chambers. These cross tubes, as well as providing seats, also provide lateral stability to the main tube.

Pockets of approximately 8 in. × 8 in. × 2 in. are permanently attached to the inboard side of the main tube in the bow end. In these pockets, accessories and supplies needed for the maintenance of the raft are provided. Oarlocks, mast holder, life line and attachments, and righting ropes are also furnished.

The carbon-dioxide inflation system is attached to the main tube by means of a manifold valve which is securely bonded to the fabric.

The cutting out of the many shapes of fabric is accomplished in an efficient way by piling many lengths of fabric and by the marking out of the pattern shapes on the top ply of the fabric. With a high-speed power-driven reciprocating or rotary-blade knife the panels and other larger pieces are cut out in one operation. Parts too small and irregular of shape to be satisfactorily cut by power knife are die-cut.

In addition to the various fabric parts, coated tape is used, which is processed in a similar manner to the fabrics, except that the tape, which is used for covering and reinforcing the seams, is made of lightweight plain-weave fabric cut on the bias. The inside coating applied next to the seam is spread on after the processed tape fabric has been vulcanized. This coating is of an air-curing type of compound. Tape fabric is rolled in holland and cut in strips of $1^5/_8$- and 2-in. widths.

FIG. 9 CAREFUL PREPARATION AND CEMENTING OF SEAMS ARE NECESSARY FOR GAS- AND AIR-HOLDING QUALITIES

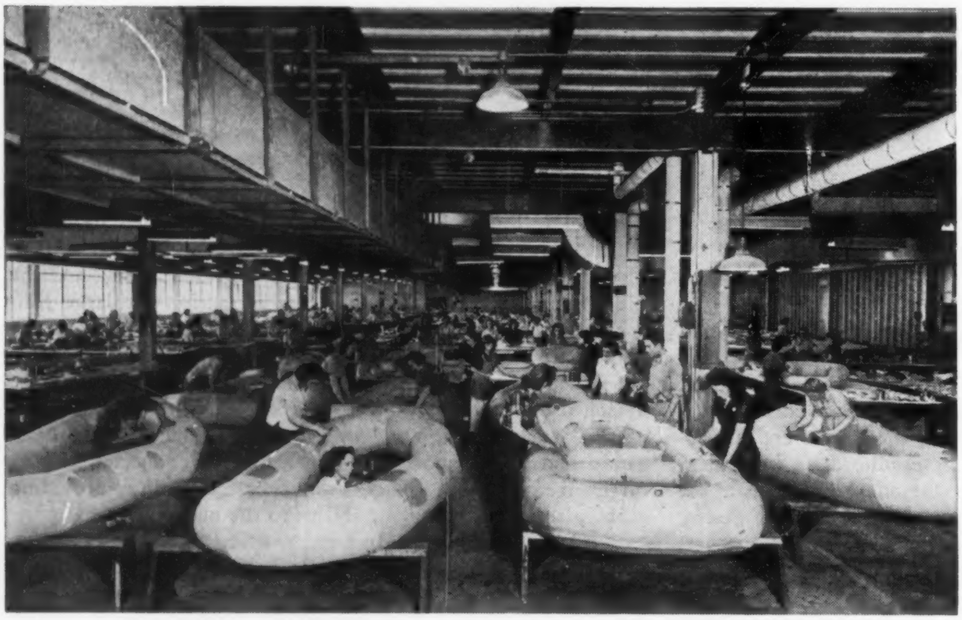

FIG. 10 RAFTS ARE BEING "FINISHED-OFF" BY ATTACHMENT OF PARTS

The holland backing prevents the setting up of the uncured backing adhesive and provides means of handling and applying to the raft.

SUBASSEMBLY AND ASSEMBLY PROCEDURES

The parts are now delivered to the respective subassembly units for seaming, sewing, or attachment, and to be made up into parts to be finally assembled to make the completed raft.

The main or principal buoyant member of the raft is made up of panels forming cylinders at angles needed to obtain the desired shape. As shown in Fig. 9, the panels are carefully buffed, washed with cleaning solvent, and cemented on areas to be seamed. The panels are then joined piece to piece, completely around the perimeter of the tube. These seams are made by lapping the fabric on the adjoining piece a distance of $^3/_4$ in. Government specifications require that the seams be as strong as the adjacent fabric. For the purpose of reinforcing the seams and to provide a secondary seal, tape is applied over the edge of the seams. This tape is applied to both sides of the seam, inside and outside of the tube.

Usually the tube panels are assembled and taped inside out so that the work of seaming is always visible. The bulkhead, dividing the tube into two compartments, is attached as the next operation. After the bulkhead has been tested to assure the necessary air-holding quality, the final close-up seam that forms the tube is made. This close-up seam is made completely around the tube except for the last few inches, when the tube is turned inside out and then the last few inches of this seam is completed. This method of seaming is to give the operator complete vision of the work, otherwise the seaming and taping would be done in a blind fashion.

The making of the seams is, of necessity, a very accurate and closely controlled operation. Materials and workmanship are of an exacting nature and every fraction of an inch of seaming must be properly made so as to provide as nearly perfect an air seal as is possible. The length of seaming in a raft for this purpose reveals the need for such accuracy. For example, in the 7-man-type raft there is approximately 145 ft of seaming in the air-holding members.

When completed, the main buoyancy tube is inflated to a pressure of 2 psi and immersed in a water tank for detection of any leaks. This provides for correction if any leak is found and assures a satisfactory raft after completion.

The rafts then are "finished-off" or completed by the application of all auxiliary parts. In Fig. 10 can be seen the work in various stages of completion. Being joined to the main tubes by cementing necessary areas and parts, are the cross tubes and/or seats, the bottom, oarlocks, mast holder, repair and supply pockets, life-line loops, life-line righting ropes, and cylinder holder. The final part to be applied is the manifold valve to which is attached the cylinder or actuating valve and the carbon-dioxide cylinder, all of the emergency inflation system.

When completed and lettered to identify the manufacturer, date of manufacture, and contract reference data, the rafts are placed on a government air-holding test. While these tests vary slightly in different branches of the service, the requirement is the same, namely, to determine and assure that each raft is of satisfactory quality and suitable for lifesaving use. Each raft is inflated with air to a pressure of 2 psi. After 1 hr,

the pressure in each raft is measured and corrected to 2 psi. This period of inflation is to allow adjustment of the fabric to shape and stretch before the actual air-loss test is started. After 24 hr, the pressure in each raft is again measured and correction made for any change in temperature. Rafts showing a pressure less than $1^1/_4$ psi are rejected. All pressure measurements are taken by means of a mercury manometer.

ACCESSORIES AND EQUIPMENT

Upon satisfactory completion of tests, the rafts are equipped with accessories and life-sustaining necessities. The items, shown in Fig. 11 (*a* and *b*), are placed in the pockets attached to the raft and/or in a central or emergency container, which is made of waterproofed fabric and secured to the floor of the raft. The amount and nature of the items have been increased and revised, based upon the many experiences of our flyers who have been forced down at sea. Also, much research by the equipment-design divisions of the Army and Navy in determining these requirements has been very effective in establishing the needs for the sustenance of life, maintenance of the raft, and means of signaling rescue parties.

This equipment varies slightly with the size and type of raft but, in general, consists of a pyrotechnic pistol with distress signals or smoke grenades, cans of drinking water, cans of sea marker dye, packages or cans of emergency rations, flashlight, match container, compass, reflector, first-aid kit, fishing kit, sail, paulin, oars, hand pump, sea anchor, 75-lb cotton cord for general use, scout knife, police-type whistle, fabric bailing bucket, and a repair kit, consisting of fabric-patching material, rubber cement, bullet-sealing plugs, sandpaper or roughing tool, pliers, and scissors.

Of all the items furnished with the rafts, most are commonplace and with which we are more or less familiar. But of particular interest we believe are several items which emphasize the distress, discomfort, and suffering usually experienced by those compelled to use them. The medical supplies furnished consist of bandage compresses, boric-acid ointment, two types of sulfa drugs, morphine, and iodine.

No doubt a psychological adjunct to the equipment, the fishing kit, is also a very valuable asset as experience has shown the need for the provision of obtaining food from the sea. This kit consists of a scoop net, various hooks, sinkers, and lines, dried bait, stone hook sharpener, a spear and line, knife and instructions for their use.

The use of most of the items in this equipment is explanatory in the name, while others need some description as to the need and use. Sea marker dye, for example, is a powder which, sprinkled on the water, spreads over a large area and coats the surface an emerald-green color which makes the location of the raft more visible to passing craft. The hand pump is used to supplement the gradual loss of pressure within the tubes. A few strokes each day will maintain full pressure. The sea anchor, conical in shape, is open on both ends, and equipped with converging lines and a 10-ft rope. The sea anchor is trailed over the stern to control drift and to keep the raft headed into the sea or current. This prevents a tendency to capsize in rough weather. The sealing plugs are about 4 in. long, tapering in diameter from $1^1/_2$ to $^1/_2$ in. with screw threads. These are inserted in bullet holes in the raft, if hit in attack by the enemy, as a means of emergency repair. When opportune, such damage can be repaired with patching material.

The paulin is made of lightweight fabric vinyl-coated and provided with grommets for attachment to the raft. It is waterproof and is orange-yellow in color on one side and a deep-blue color on the other side. This piece of equipment is used for catching rain water; as a shelter from the rays of the sun or inclement weather; and as a means of camouflage, using it with the blue side up so as to be less discernible to enemy aircraft.

(*a*)

(*b*)

FIG. 11 MUCH RESEARCH IS BEHIND LIFE-SUSTAINING NECESSITIES CARRIED IN EACH RAFT

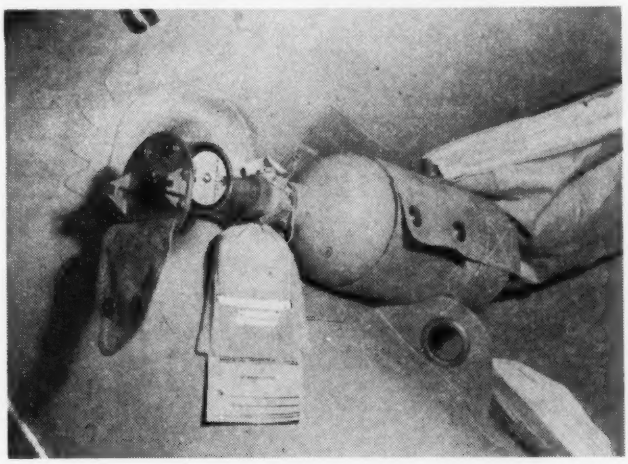

FIG. 12 VIEW OF CARBON-DIOXIDE VALVE AND CYLINDER IN PLACE ON RAFT

The sail, made of the same material as the paulin, is used by the insertion of oars in slots or pockets to provide the mast and crossarm. Securing ropes are then attached.

CARBON-DIOXIDE INFLATING APPARATUS

With inclusion of the accessory equipment, this completes the raft and it is then folded and inserted in the carrying case. The raft is so folded as to permit ready access to the carbon-dioxide cylinder valve. The carrying case is made of a duck fabric, waterproofed with a vinyl coating. It is constructed by sewn seams and with snap fasteners for the closure. It is equipped with a spring wire frame.

The release of the carbon-dioxide gas for emergency inflation is accomplished by pulling a wire cable handle out of the valve mechanism. On the opposite end of the wire cable is a small

FIG. 13 ANOTHER DEVELOPMENT IS THE ONE-MAN PARACHUTE-TYPE RAFT FOR FIGHTER PLANES

FIG. 14 THE "MAE WEST" LIFE VEST IS THE FLIER'S MEANS OF TEMPORARY FLOTATION

ball which actuates the valve. The raft inflates immediately, opening the carrying case automatically. The raft inflates through the manifold valve, and this valve is designed to equalize the amount of gas injected into each compartment of the main tube. The inlets of the valve are fitted with spring checks to allow removal of the carbon-dioxide cylinder without loss of pressure in the raft.

The cylinder is constructed of a special steel alloy and wire-wrapped to prevent shattering if struck by gunfire. A sufficient amount of carbon-dioxide gas, at approximately 900 psi pressure, is provided to inflate a given raft to $1^1/_2$ psi minimum at sea level in not more than 8 sec at a temperature of 70 F. The gas expands approximately 450 times the compressed volume.

The carrying case completely shed from the inflated raft is attached to the raft by means of a line, which in turn is attached to a rope bridle on the carrying case. When used in actual service, the open case acts as a drag on the raft to prevent it from drifting too far away from a plane or distressed flyer in the water.

ONE-MAN-TYPE RAFT

The lightweight "champ" of all the rafts is known as the "one-man parachute type." Different in shape and use, this raft when packed with all accessories measures but 15 in. $\times$ 14 in. $\times$ $3^3/_4$ in. and weighs only 16 lb. The raft alone weighs but $5^1/_2$ lb and the remainder of the weight is in the accessories, case, and carbon-dioxide inflation system.

As shown in Fig. 13, the raft is of unconventional shape. The main tube varies in diameter from 7 in. in the stern to 12 in. in the bow. This tapering feature of the tube is provided to give an "even keel" and a satisfactory buoyancy where the center of gravity of the occupant is well toward the larger end. Lightness and compactness are the prime features in the design of this raft.

The one-man parachute-type raft is so named because it is a part of the parachute equipment. The case, or seat pack, is attached to the harness of the parachute and is carried in a position so that the flyer sits on it.

This raft is equipped with a carbon-dioxide inflation system with supplemental inflation provided through an oral tube. Handles on each side and on one end provide means of climbing into the raft from the water. These handles also serve for tying and securing accessories to the raft. It is equipped with a sea anchor, bailing cup, weather cloth, drinking water, sea marker dye, first-aid kit, paddles, bullet-sealing plugs, and repair kit, consisting of the usual patching materials, cement and tools.

"MAE WEST" LIFE VEST

In addition to the life raft, fliers are supplied with an inflatable life vest which is worn by all flying personnel. It is worn in the position shown in Fig. 14. This vest is made of single-ply coated fabric, similar to that used in some types of life rafts. The vest is dual-compartmented for safety and is inflated by means of a carbon-dioxide mechanism. Inflation is supplemented by oral inflating tubes on the right side and close to the user's mouth. Waist and crotch straps are provided to attach the vest securely to the body.

When a flier is forced to abandon his plane over water, having bailed out and descending by parachute, he pulls one of the cords attached to carbon-dioxide inflation system which inflates one of the compartments of the vest. Upon dropping into the water the parachute and harness are quickly discarded, then the other compartment of the vest is inflated in the same manner as the first. The vest provides sufficient buoyancy to float a fully clothed man and equipment well up in the water. Immediately he pulls open one corner of the case of the one-man raft and with a twist or pull on the valve inflates the raft. This inflation is almost instantaneous.

The one-man raft is a preserver that is the flier's salvation as it keeps his body out of the cold water if his fighting is in the northerly sectors, and leaves no dangling legs for sharks in the case of temperate or tropical waters.

In the event of a crash landing on water, and where it is impossible to bail out, an ingenious method of putting the large life rafts quickly into use has been provided. A simple mechanism snaps open the locker hatch and ejects the raft a number of feet from the plane by means of a powerful spring. A line attached to the plane and to the pull cable on the raft-inflation mechanism opens the valve automatically and inflates the raft.

LIFEBOATS FOR SURFACE SHIPS

To indicate the trend in the use of inflatable life rafts and the possibilities that may be ahead in the postwar period, the latest

development of a larged-size boat is shown in Figs. 15 and 16. This raft accommodates 25 men with room for 1000 lb of provisions. It is 25 ft long, 10 ft wide with a 24-in-diam buoyancy tube. Its rated capacity is 6000 lb and will carry twice that load. It is equipped with an inflatable removable floor for insulation against cold, which also provides longitudinal and lateral stability. It is equipped with seats and inflatable cross tubes. Also provided, as shown in Fig. 16, is a weather cloth or wind break to protect against the driving wind of the north climates.

Because of the ever-decreasing deck and storage space on modern warships, due to heavy armament and additional fighting equipment, the inflatable life raft is well adapted to these circumstances. When folded away in the canvas packing case this raft measures but 7 ft $\times$ 5 ft $\times$ 18 in., hence the raft can be lashed to a deck structure with the use of comparatively little space.

The main or supporting tube of this raft is inflated by carbon-dioxide gas and immediately on opening of the cylinder valves, the raft can be thrown overboard and boarded. Within a very few minutes the raft will inflate sufficiently to provide maximum buoyancy. In the meantime, hand pumps are used to inflate the cross tubes and floor. The air inflation and putting up of the weather cloth is accomplished in a few minutes.

PEACETIME USES FOR INFLATABLE RAFTS

What effect should the experiences of our armed forces in the use of inflatable life rafts have on the possibilities of widespread use of such products for all ships and aircraft in the postwar period? For many years airplanes flying over water have used this type of equipment. There is every reason why this will continue and increase with the growth of aviation. With the possibilities of providing a place for every soul aboard surface vessels, should disaster strike, why should not such equipment be used? In providing a similar safety and means of maintaining life as that now afforded the flying personnel of the armed forces, will this same comparatively more efficient equipment be adopted? With the improved durability and increased life expectancy of this type of life-saving equipment, due to research during the war period, should not this have a tremendous effect on its use in the postwar time?

FIG. 15 THE LATEST DEVELOPMENT IS A 25-MAN LIFEBOAT FOR USE ON SURFACE VESSELS

FIG. 16 LIFEBOAT WITH WIND BREAK ERECTED

The answer will come at the end of the war. In the meantime, the life raft is performing a meritorious job in saving our men from perishing in the sea so they may live to fight again.

FIG. 17 EXPERIENCE HAS SHOWN THAT THE FISHING KIT IS A VALUABLE ASSET IN PROVIDING MEANS OF SUPPLEMENTING FOOD AND WATER

TOOL-LIFE TESTS

Proposed Standard of Tool Life Tests for Evaluating the Machinability of Single-Point Tools, Cutting Fluids, or Materials Cut[1]

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THIS standard covers test methods for the appraisal of single-point cutting tools other than those of cemented carbide; as carbide tools fail or wear somewhat differently from those of steel and cast nonferrous alloys, a separate procedure for rating them is being developed.

A *Single-point tools* may be of a solid type or tipped type. Solid tools are those in which the point of the tool is of the full shank section and consists entirely of metal-cutting material. Tipped tools are those in which a relatively small piece of metal-cutting material is attached to the tool shank to form the point.

B An *outline of any test* to evaluate the performance of single-point tools must cover:

(*a*) The objective of the tests: to establish a performance rating of the tool, the material cut, or the cutting fluid.
(*b*) The method of test.
(*c*) The factors, including the apparatus used, listed and specified.
(*d*) The method of analysis of the data and their interpretation and correlation with actual shop conditions.

C The *merits of a tool*, the metal cut, or the cutting fluid may be based singly or collectively on:

(*a*) The tool-life cutting-speed relationship.
(*b*) Surface quality produced.
(*c*) Form of chip produced; well-broken-up chips being considered more desirable than long stringy ones.
(*d*) Forces, energy, or power involved.

D These four factors should be determined for conditions as near as possible to the actual *cutting conditions* for which comparative values are desired, such as:

(*a*) Light, intermediate, and heavy cuts on an abrasive material or one which gives discontinuous chips, such as cast iron.
(*b*) Light, intermediate, and heavy cuts on steel (of several types and structures).
(*c*) Tools, cuts, and materials for general-purpose work.
(*d*) Cuts, tool materials, cutting fluids, and materials for specific commercial practice.

It is believed that tests with one type or shape of tool used to evaluate several materials or cutting fluids might give ratings different from those obtained with another type of tool material or tool shape. One type of cutting fluid might not give ratings of the same order as another type when several tools or materials are being compared. Further, one group of materials of one structure might not have the same ratings as those with a different structure.

E *Variable factors* involved in each test are:

(*a*) The machine tool—its type, condition, etc.
(*b*) The material cut—its analysis, structure, hardness, strength, etc.
(*c*) The tools—the material, treatment, and shape.
(*d*) The cutting fluid—class, properties, and method of manufacture.
(*e*) The size of cut (depth of cut and feed) and its shape.

Each of these variable factors is discussed in what follows to indicate information needed to compare the test data with those obtained elsewhere.

F Under *machine tool* should be listed information as to:

(*a*) Type
  (1) Engine lathe, turret lathe, screw machines, etc.
  (2) Manufacturer, model, and age.

(*b*) Condition—type of bearing, spindle mounting, runout, and state of repair.
(*c*) Capacity or size—swing over the ways, distance between centers, bar-stock size, maximum length to be turned.
(*d*) Method of power transmission—belt drive to step-cone pulley, belt drive to constant-speed pulley, geared head, direct motor drive, etc.; size and type of motor.
(*e*) Speeds available—in spindle revolutions per minute.
(*f*) Feeds available—in inches per revolution.
(*g*) Tool mounting and work-holding means—types of support, method of holding the tool and setting its nose on center.

G For the *material cut*, information should be given as to:

(*a*) Composition
  (1) A.I.S.I., S.A.E., W.D., N.E., etc., types or chemical analysis and an indication of whether the workpiece is a laboratory specimen or a production part.
  (2) Physical condition
    Grain size and structure—microstructure
    Thermal treatment
    Physical properties
      Tensile strength
      Yield point
      Impact
      Hardness
      Reduction of area
      Elongation
      Work-hardening capacity.
  (3) Scale or surface condition
  (4) Shape and rigidity, continuous or intermittent cutting
  (5) As-forged, as-cast, or as-rolled (cleaned, pickled, blasted, hot-rolled, or cold-drawn).

The size of the test piece must be adequate to assure rigidity and avoid chatter. The rigidity of the machine and the condition of the spindle which will lead to reproducibility, or direct comparison with similar tests conducted elsewhere, are to be specified and the test procedure prescribed. The test log should be heat-treated to a uniform physical condition and should be representative of commonly used steels in a similarly heat-treated condition to that which is encountered in shop practice.

H The *cutting tools* are to be specified as solid or tipped. If

[1] This proposed standard is a result of several meetings of Technical Committee 21 of the American Standards Associaton, Sectional Committee B5 on the Standardization of Machine Tools and Machine Tool Elements. The membership of this committee is as follows: O. W. Boston, chairman, E. E. Griffiths, E. J. Hergenroether, Maj. P. L. Houser, W. E. Jominy, M. F. Judkins, H. L. Moir, H. J. Vandestadt, G. P. Witteman, F. L. Woodside, and L. T. Weller.

Contributed by the Special Research Committee on Cutting of Metals and presented at the Annual Meeting, New York, N. Y., Nov. 29–Dec. 3, 1943, of The American Society of Mechanical Engineers.

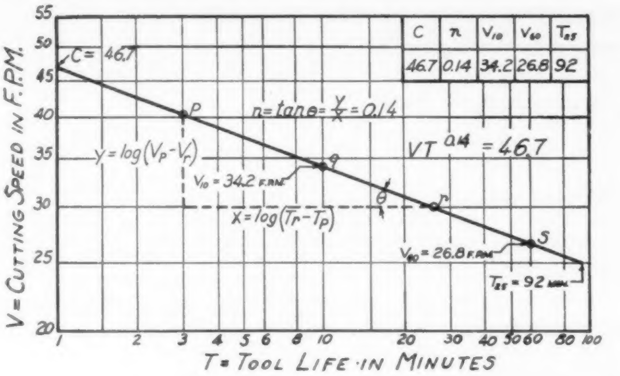

FIG. 1 THE CUTTING-SPEED TOOL-LIFE LINE FOR TURNING WITH SINGLE-POINT TOOLS, AS DETERMINED FROM EXPERIMENTAL TESTS AS AT p, q, r, AND s

(Cuts in annealed S.A.E. 2340 steel were dry at 0.200-in. depth and 0.050-in. feed with high-speed-steel tools of the 8-22-6-6-6-15-$^3/_{64}$ shape. The log-log scale has a vertical scale 2.67 times the horizontal.)

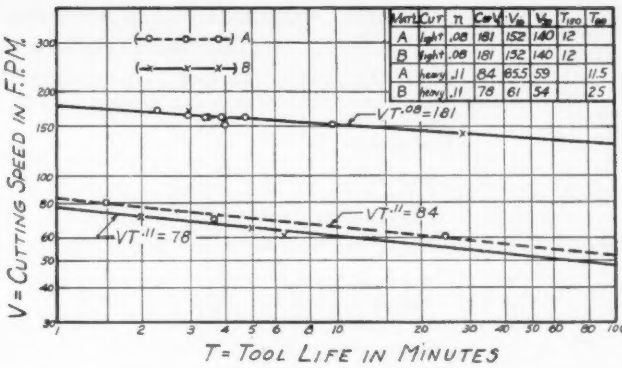

FIG. 2 TOOL-LIFE CUTTING-SPEED RELATIONSHIP IN TURNING TWO FORGED DIE STEELS KNOWN AS "A" AND "B"

(Both steels were oil-quenched and tempered to give a Brinell hardness of 363. The tools of high-speed steel are described in the text. Two cuts were made dry—one with a feed of 0.0127 in. and a depth of cut of 0.0125 in., and the second had a feed of 0.0127 in. and a depth of cut of 0.100 in.)

tipped, the method of attachment and the material of the shank should be given. All materials are to be described fully. The size of tip and shank should follow the American Standards Association practice. The supporting surface quality and area, the fit of tool to holder, and method of clamping are to be described. The clamping method, whether single-point bearing or a setscrew on a pad, is to be specified. The amount of overhang should be limited to the width of the tool bit.

The shape of the tool point is to be specified. Tool angles and data such as back rake, side rake, end relief, side relief, end-cutting-edge angle, side-cutting-edge angle, nose radius, setting angle, chip-breaker groove or shelf, grinding wheel used, and type of machine, together with lapping or honing practice, should be given in detail. It is suggested that the tool point nose have a $^1/_{32}$ in. flat, a 45-deg chamfer, a radius of at least 1/32 in., or a sharp point. In any event, the radius should be measured and recorded as this is an important factor influencing tool life. The cutting edge is always to be placed on the center line of the work.

A convenient key as to tool shape is as follows: 8, 22, 6, 6, 6, 15, $^3/_{64}$. This means that the tool has 8-deg back rake, 22-deg side rake, 6-deg end relief, 6-deg side relief, 6-deg end-cutting-edge angle, 15-deg side-cutting-edge angle, and $^3/_{64}$-in. nose radius. The setting angle is 90 deg when the axis of the tool shank is at right angles to the axis of the work.

J *Method of test for cutting-speed tool-life relationship.* In a test to evaluate tools, materials, or cutting fluids based on the relation between cutting speed and tool life, there should be but one variable, namely, the material, the tools, or the cutting fluid. If it is the tool material that is under consideration, then the material cut and the cutting fluid should be kept constant, together with the shape of the tool and the size and shape of cut. For each class of material machined there is naturally a tool form best suited for the purpose. This tool form might vary considerably, however, depending upon whether it is a roughing cut simply to remove metal at the greatest possible rate, or whether some specific form of cut is required as in screw-machine work. A number of standard tests should be set up for this one objective, that is, for each cutting-speed tool-life relationship. For the tool material tests, for example, the following should be kept constant:

(1) Tool shape.
(2) Depth of cut and feed.
(3) Setting angle of the tool.
(4) Analysis and heat-treatment of the material being machined.
(5) Type of cutting fluid used; dry cutting is included as a cutting fluid.

As a further complication, the size of cut must be varied, inasmuch as the objective in some cases is to rate tool materials for light cuts at high speeds, others at intermediate cuts, and still others at heavy cuts. From this it appears then, that in order to set up machinability ratings for tool materials (to be specific), there must be a number of specific tests outlined, so that that particular test which most nearly reproduces the commercial conditions under which the tools are to be used may be selected.

The feed is to be represented in thousandths of an inch per revolution of the work or cutter. Cuts and feeds which are suggested for tests to cover light, intermediate, and heavy cuts are:

(1) 0.005-in. to 0.010-in. depth of cut and 0.002-in. feed.
(2) 0.100-in. depth of cut by 0.0125-in. feed.
(3) $^1/_8$-in. depth of cut by 0.020-in. feed.
(4) $^3/_{16}$-in. depth of cut with 0.005-in. or 0.010-in. feed.
(5) Maximum of $^1/_4$-in. depth of cut with 0.03-in. to 0.05-in. feed.

The cutting speed is to be measured on the uncut work surface ahead of the tool. It is to be recorded in feet per minute.

There are two general methods now in common use for obtaining machinability ratings based on tool life:

(1) To obtain the tool life when cutting under standardized conditions at a constant cutting speed, as in turning cylindrical test bars.

(2) To obtain the tool life when cutting at a uniformly increasing cutting speed, as in facing.

For the first type, the tool life for each tool material can be obtained for several different cutting speeds, in accordance with the following procedure: The formula expressing the relation between cutting speed and tool life between grindings for a given tool, material, feed, and depth of cut is $VT^n = C$, in which V is the cutting speed in feet per minute, T is the tool life or duration of cut between grindings in minutes; C is a constant depending on the conditions and equals the cutting speed for a tool life of 1 minute; and n is the slope of the straight line on log-log paper. If three or more turning tests were run on a metal in which all factors were kept constant except the cutting speed V, a definite value of tool life at failure T would be obtained at each cutting speed, as indicated by points p, q, and r on the lowest curve in Fig. 1. These and more points plotted on Cartesian co-ordinates would indicate a parabolic curve. On log-log paper they produce a straight line. The equation of a straight line on Cartesian co-ordinates is $y = mx + b$, but on log-log paper it is $\log y = m \log x + \log b$

TABLE 1 SUGGESTED DATA SHEET FOR CUTTING-SPEED TOOL-LIFE TESTS IN TURNING

(These data are plotted in Fig. 2 to form the two highest lines)

Tools: 3/8 in. sq × 3 in. long, high-speed steel (R.C.S.)
Material cut: Die steels A and B forged log 6 in. diam × 20 in. long, 363 Brinell
Depth of cut: 0.0125 in. Feed: 0.0127 in.
Tool angles: Date: 6/4/38

Back rake	8	
Side rake	14	Observer's name:
End relief	6	
Side relief	6	Tool support: Special solid tool holder 1 1/2 inches × 2 1/2 inches × 4 inches
End cutting edge	6	
Side cutting edge	15	
Nose radius	3/64 in.	Cutting fluid: Dry
Setting angle	90 deg	
Back slope of bit in holder, 10 1/2 deg		Room temperature: 75 F

Test number	Tool number and Rockwell C	Work diameter at cut	(a) Log sect	Cutting speed, fpm	Tool life, in min	Cutting fluid temp	Remarks	
5	(b) 44T-64	5.650	4	164.8	2.94		Typical cup failure	Die steel A
6	67T-64	5.650	3, 2	163.8	3.90		Typical cup failure	
57	80B-63.5	5.275	3	161.6	4.77		Typical cup failure	
59	45B-64	5.225	3	151.5	9.87		Typical cup failure	
34	78B-64	5.030	4, 3, 2	161.6	4.08		Typical cup failure	Die steel B
35	75T-64	5.03–5.00	4, 3, 2	141.4	28.27		Typical cup failure	
37	64T-64	4.905	4, 3, 2, 4	151.5	10.16		Typical cup failure	

(a) 20-in. log divided into four sections of 5 in. each, numbered 1 to 4 from chuck.
(b) Tools ground on both ends, one end T, other B.

(or $\log V = m \log T + \log C$). The slope of the line n is negative and equals y/x; then $V = T^{-n}C$, or $VT^n = C$. (In Fig. 1 y as scaled should be divided by 2.67, as the vertical ordinate scale is 2.67 times the horizontal.) When $T = 1$, then $C = V_1$ (in feet per minute for a one-minute tool life). V_{10} (the cutting speed in feet per minute for a ten-minute tool life) as read from the curve is 34.2, V_{60} is 26.8, and T_{25} (the tool life for the cutting speed of 25 fpm) is 92 min. These values, or similar ones needed to compare this curve with another, are determined and summarized in Fig. 1.

In Fig. 2 are shown the results of cutting-speed tool-life tests on two die steels, both heat-treated and tempered to give a Brinell hardness of 363. The material was furnished as forgings 6 in. in diameter and 20 in. long. Two different sizes of cut were used when turning dry. One cut was a finishing cut of 0.0125-in. depth and 0.0127-in. feed. The second was a heavier cut of 0.100-in. depth and 0.0127-in. feed. High-speed-steel tools of 18-4-1 type (known as Red Cut Superior) were used. These tool bits were held in a solid steel tool holder 1 1/2 in. wide, 2 1/2 in. deep, and 4 in. long by one set screw on the top. The tool-holder angle (back rake) was 10 1/2 deg and the setting angle was 90 deg. The tool point was ground to have working angles of 8-14-6-6-6-15-3/64. The tool bits were 3/8 in. sq.

A sample data sheet is shown as Table 1. The values of cutting-speed tool-life are shown plotted in Fig. 2. The comparative results are shown as a table in Fig. 2. For the light cut, both steels give the same data, i.e., the same slope n of 0.08 and the same value of C of 181. This means that both lines have the same slope and pass through the same point, therefore the machinability based on cutting-speed tool-life under these conditions is identical and values of V_{10}, V_{30}, and T_{150} are equal. For the heavy cut, the slope as represented by n is 0.11, indicating these lines to be steeper than those for the light cuts. This is disadvantageous. The value of C for steel A is 84, while that for B is only 78 fpm. The former is 6 fpm or 7.7 per cent higher. V_{10} for A is 65.5 and for B is 61. The former is 4.5 fpm, or 7.4 per cent higher.

For the light cut, the value of T_{150} is 12 for both steels. For the heavy cut T_{60} is 11.5 min for steel A and 25 min for B. The latter is 117 per cent greater.

These results show that the two steels machine equally well, and favorably with the low slope, at light cuts, but that steel A machines better than B at the heavy cuts.

In this same manner, keeping the cutting fluid and material constant, the cutting tools of different shape or material may be evaluated.

THE minute that war is over, and particularly if the prospective conditions of the peace are such as to indicate a long period of freedom from hostility, we are bound, I think, to see an immediate disintegration of the present machinery of science and technology. Men and women will yield to the deep-seated urge to return to their erstwhile modes of life, and in addition no one will wish longer to devote time and energy to objectives which have lost their reality. Scientific men will wish to return to life in a free intellectual world, there to pursue the quest for new knowledge. Industrial research men and technologists will hasten to take up again the things that once interested them and to expedite filling in the gaps made by the inroads of war and the forced laying aside of promising new applications of science. There will be a dearth of highly trained men for fundamental science research for general application, and a large number of men trained in specific applications. Much of what we have done during the war period will be of no peacetime value because it is concerned wholly with the things of war. From "The Promise of Technology," by Dr. Frank B. Jewett, *Science*, January, 1944, pp. 4-5.

RECOMMENDED[1]

By IRVING KNICKERBOCKER

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Most of us have a good healthy curiosity about ourselves and other people. We would really like to know, if the knowledge were not too hard to come by, more about us and them. It would be hard to find a man who did not feel that he was something of a psychologist when it came to interpreting other people, and all of us if we see fit to do so can hold forth at length in explanation of our own behavior. Men have apparently always been interested in understanding and controlling the behavior of others. Most men are still dissatisfied with both their understanding and their ability to control.

Most of us have probably had, when we turned to books for an answer, much the same experience. Those books the titles of which led us to believe they contained our answer seemed to fall into one of two classes. In one class were the books written to sell by men who knew how to make their subject matter popular even though their knowledge of the subject matter might be slight. These books have been in general a rather slap-happy conglomeration of rules-of-thumb, anecdotes, shrewd observations, cases, and guesses. They usually have lacked the meaningfulness which is acquired as the result of an integrated and systematic approach to the subject matter. The other class of books has consisted of an earnest attempt to condense the experimental background of psychology into a more or less readable introductory textbook. These books have been influenced by the academic atmosphere and by the incompleteness of the experimental background. They usually portrayed a peculiarly static individual with some well understood parts, some vaguely conceived, and quite a few parts which were not there at all. There has been until recently, then, no book which could be recommended wholeheartedly to the layman as containing the type of material presented in the way he wanted.

In recent years, a fusion of the experimental-academic with the clinical-medical background and experience has given rise to a new way of thinking about human behavior. Out of the theories and practice of the clinics and of the therapists who help solve real-life problems, backed by an increasing amount of experimental evidence, comes the rough shape of a new systematic approach involving a dynamic concept of the whole human being. This dynamic psychology is probably the closest psychology has ever come to answering the layman's common question which is in itself dynamic, "What makes them tick?"

From this new way of thinking—this dynamic approach—have come in recent years three new books. These books deal with real people living a real life. They examine real problems. They present generalizations which are applicable to the living stuff of existence. They seem to be what the layman has been asking for. A book by Maslow and Mittleman[2] is the first good introductory text in dynamic psychology. It contains a wealth of material simply presented. It was not, however, designed for and does not exactly serve to fit the needs of the average layman. It offers if anything too much material, and places on the reader perhaps too great a responsibility for integrating that material. It is, however, a treasure house for the reader who is willing to dig a little, discard a little, in order to get the gems which most precisely fit his specific requirements.

"The Happy Family,"[3] by Levy and Munroe, is a book about growing up in a family. It is one of the sanest, most realistic, and happiest events in psychological publishing. Although written by two people with the richest of medical and psychological experience, it is so simply done as to make the reader wonder if the authors could really be expert and know what they are talking about.

The third book, Langer's "Psychology and Human Living,"[4] is the first to go rather directly about the job of providing a relatively brief and simple answer for the layman who asks, "What has psychology to offer that will help me to a greater understanding of myself and others?"

Such a book as Langer's makes several rather definite demands upon the reader. It requires a thoughtfulness within reason and an understanding not so much by the head as by the heart. Therefore the reading of this book is apt to be somewhat of an adventure.

Langer finds the setting for his book in a consideration of the extent to which our beliefs are patterned by our culture and by an examinaton of theories past and current which we use uncritically for an explanation of human behavior. We explain certain events in a man's life by saying that he has been "lucky." We think of the "will" as coming into play at certain periods in a person's existence. We explain certain behaviors by saying, "He's a chip off the old block." We excuse a great deal by saying, "Well, it's just 'human nature' and that's all there is to it." Such an examination of the methods we use today for explaining human behavior serves as an excellent background for a more systematic conception.

Langer devotes several chapters to a careful presentation of the theory of motivation which seems to be rapidly gaining acceptance among practicing psychologists and which should prove equally practical for the layman. He then proceeds to lay out for the reader in two chapters, "Growing Into a Social Individual" and "The Integration of the Personality," the life story in a sense of each one of us, a generalization of how we get to be the way we are. Perhaps the most startling and also most intriguing theme which runs through these chapters is the psychologist's account of the development of conscience. Most of us seem to take our conscience for granted. We know we have it. We find it quite a bother at times and at other times a help. It will probably scarcely surprise most readers to find that conscience plays an immensely important role in governing our behavior. They may, however, be considerably astonished at the details of the account, and the immense complexity of the mechanisms through which conscience governs their behavior.

Succeeding chapters deal with anxiety, insecurity, inferiority, and guilt. Though most of us have not experienced all of these unpleasantnesses, all of us have experienced some of them. To feel anxious, or insecure, or inferior, or guilty and not to know why, is a not too uncommon experience. As we read these chapters and get a greater insight into the reasons for our worries and sleepless nights, our jitterinesses, our inferior feelings, and our guilty periods, we cannot help but get at the same time a feeling of considerable pride in being at once such

[1] One of a series of reviews of current economic literature affecting engineering, prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of The American Society of Mechanical Engineers. Opinions expressed are those of the reviewer.

[2] "Principles of Abnormal Psychology," by A. H. Maslow and B. Mittleman, Harper and Brothers, New York, N. Y., 1941.

[3] "The Happy Family," by J. Levy and R. Munroe, Alfred A. Knopf, New York, N. Y., 1938.

[4] "Psychology and Human Living," by Walter C. Langer, D. Appleton-Century Co., Inc., New York, N. Y., 1943.

a highly complicated, tremendously rich, and involved being, who nevertheless, somehow, so simply manages to get along.

All of us from time to time get into real-life situations, a "jam" as it were, and spend anxious days looking for a solution which we cannot seem to find. In lieu of a solution most of us at one time or another have tried to find an escape. The chapter on "Escape" in this book is one of the more valuable aids to an understanding of human behavior. Whether we escape by drinking or working like the very devil, whether we escape by conforming exactly so as always to be right, or rebelling entirely so as to avoid the whole situation, an understanding of what we are doing seems to help.

Throughout the book, mechanism after mechanism which we commonly use for dealing with our problems without ever having realized that we used them is clearly described and exemplified. An understanding of these mechanisms in ourselves, the recognition of them in others, is a real and practical aid to comprehending just why people do the things they do.

Characteristic of the dynamic approach is the account of what happens to the strong drive and urgent emotions which at one time or another we have but don't like to look at and tuck away somewhere and hope we can forget. They apparently come back and exert their influence despite our watchfulness. The way they come back and the way they evidence themselves makes up one more of the fascinating chapters in this book.

In the final chapter of this book, the author presents the thesis that a greater understanding and control of human behavior is not merely something that some of us may acquire because we are interested but is rather an obligation which we must accept if our civilization is to survive.

"It is a horrible condemnation of our civilization that technical knowledge has advanced to the point where its achievements border on the miraculous, while our knowledge of man has remained at almost a medieval level. Tremendous bridges, skyscrapers, tunnels, steamships, airplanes, and what not are designed and built with the greatest precision . . . . but we can scarcely make a beginning at shaping the lives of the individuals who are to use them. The inventions of our sciences are being turned to the destruction of thousands and hundreds of thousands of human beings who might have enjoyed them to the advantage of everybody had they been given a better opportunity." (Langer, pp. 280–281.)

"To improve our own present forms of adjustment by using every possible means at our disposal is, perhaps, our first task but not our last. We are not the end-product of our civilization or the world. Many generations will come after us. They are our responsibility. Are we content to pass on, through future identifications with ourselves, our personal shortcomings, our inadequate adaptations, our insecurities, our prejudices, hatreds, fears, guilts, and ignorance? Scarcely a single one of us would wish to do so. Whatever our lives may be at the moment, we all have a secret and implicit faith in the capacity of man to make the world a better place in which to live. We all hope that our children may be among those who will inhabit it and that they will find a greater degree of happiness than we ourselves have been able to find.

"But faith is not enough. We must do something to turn that faith into reality. Most of our parents have made attempts in this direction. As we have seen, many of them have missed their target. In the false belief that such things as wealth, position, college educations, comforts, outer security, and so on are the vehicles to happiness, they have slaved and saved to provide them for us. We now know that these are relatively unimportant. What really counts is the inner security obtained through an adequate integration of our fundamental needs into a stable and social personality—a personality built on love, tolerance, and understanding, able to utilize the opportunities for the expression of its needs to the fullest." (Langer, pp. 279–280.)

Critical Transition Period After V Day

(Continued from page 106)

directed primarily to the removal of the present intolerable burdens on business enterprise. For the past generation tax economists as a class have directed their attention almost exclusively to an equitable "distribution" of income and wealth. Now most of these individuals have suddenly discovered that what really matters is the "creation" of wealth and the provision of employment. As a result, they are being driven to conclusions on tax policies which they would have regarded as highly reactionary a few years ago. From this changed psychology will come a strong pressure for reduction, and possibly eventual elimination, of corporate income taxes and a shift in the tax burden from corporations to individuals.

The foregoing problems are merely segments of the one central problem which will be the attainment of new high levels of production within the shortest possible period of time. If we can rally all sectors of our economy around this one basic concept and co-ordinate all national policies of Government, business, labor, and agriculture in relation to it, we shall have a fighting chance of winning the peace.

GOVERNMENT, BUSINESS, AND THE PUBLIC MUST WORK OUT THE SOLUTION

The author would like to be able to state that the only thing needed is for the Government to remove the present shackles on business and that unfettered private enterprise would then solve all our problems. However, it is feared that this is a dangerous fallacy. Business cannot possibly do this job alone, and it does not help the cause of free enterprise to assert that it can.

What is called for will be a vast co-operative undertaking in which business, labor, agriculture, Government, and the general public will each be required to do its full share. It will not be enough to ask Government to get out of the way of business. In addition, decisive and constructive action by Government will be needed in many areas.

In time of war we attain a high degree of national unity through the strong pull of patriotism. This is relatively easy to achieve, because the issue of national survival is readily understood by all. What we shall need is a new kind of peacetime patriotism which will give us national unity, with a common purpose and direction, during the crisis of the postwar transition. Although this will clearly be much more difficult to achieve, it is believed we have an excellent chance to do so by means of the rallying cry of production and employment.

We must realize of course that the attainment of high levels of production and employment is only half the job. Even if we succeed in our primary objective we shall still face the complex and even more difficult task of stabilizing production and employment at the high levels we have attained. Involved in this long-range problem are such questions as that of ironing out the peaks and valleys of the trade cycle, the control of monopoly and the self-regulation of business, and of maintaining the health of small business in our national economy. The C.E.D. research program already contemplates broad studies in these fields.

No group in the country will have a more important role in the task that lies ahead than the engineers. The nation will have need of all the talent and energy that can be brought to bear on these problems. In addition, all of us will have need of faith and courage worthy of our fighting men who are winning the war for us all over the world. Only thus can we hope to win the peace and preserve for them an America to which they will be glad to return.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

War Production in 1944[1]

NATIONAL ASSOCIATION OF MANUFACTURERS

PLANS for American war production must be based upon some belief as to the duration and intensity of the war. Hundreds of contradictory prophecies and predictions have poured from the press and radio as to the nature of the fighting that looms ahead and the time when the enemy will collapse. Germany has been badly battered by our bombings. She has suffered heavy losses in the Russian campaign. She is being hard pressed in Italy. But the Nazis still have great fighting power. They are masters of the arts of fortification and defensive strategy. They have fighter planes, tanks, and defensive artillery in large numbers. As their lines of communication grow shorter they can offer more concentrated resistance than before. And the morale of the German people, while it has certainly deteriorated, has evidently not sunk as yet to the point where we can expect an internal breakdown in Germany. The fight in Europe looks like a long, hard, bitter fight. Unless we are exceptionally lucky, it will be costly in lives beyond the expectations of most of the American people. The cost in matériel will be equally heavy.

What I have said of the European war can be underlined with respect to the Asiatic war. Our experience at Guadalcanal, in the campaign on New Guinea, and more recently at Tarawa, shows that the Japanese are tenacious, well-equipped, and better fortified than many optimists expected. Moreover, they have access to large quantities of raw materials, and their mainland industries are untouched by bombings. Japan will be a tough, dangerous, persistent enemy. If anyone of us still clings to the silly delusion that the Japanese will be a pushover for us after Germany is knocked out of the war, let him talk to some of the officers and men who have come back from the Pacific theater. They will tell you that only a major military effort, a big war, will bring Japan to her knees.

The Japanese strategy is no mystery. They hope to make a long war out of it—a war so costly to us in blood and wealth that we will grow tired of it and agree to a peace that will leave them in possession of most of their conquests. Foolish optimism in this country about the early collapse of Japan will only play into the hands of the clever strategists in Tokyo.

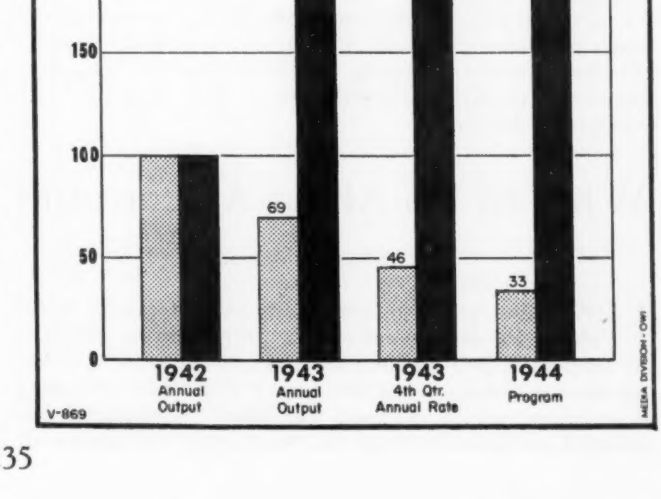
I do not pretend to know how many years the war against Japan will last. But I feel convinced that there will be no quick knockout in that fight, and we will not win with our left hand alone. We need to be ready to throw punches with both fists for as many rounds as are required, in order to win the only kind of victory that will satisfy our people and redeem our pledges to the world—unconditional victory. With the concept of a hard prolonged war as our starting point, we of the War Production Board have made our plans in collaboration with the armed services.

The 1944 over-all schedules call for performance higher even than our current rate—a performance 80 per cent above our 1942 record. These schedules are continuously under review, and it is the constant effort to see that we shall produce only things which are genuinely needed for the successful prosecution of the war. I believe that in general subsequent revisions will not be upward. But after carefully canvassing the matter with all of the procurement agencies concerned, I can offer you my considered opinion that, barring unexpectedly early termination of the war in the European theater, such revisions will not substantially reduce our 1944 production below present levels.

This year it was relatively easy for people to grasp the war-production problem. In almost every war industry the call was for greater output. But the production job for 1944 will be much harder for the public to understand. Next year we shall be saying to those responsible for aircraft production, "Keep the pressure on; give us more." At the same time we shall be saying to the shipbuilders, "Keep your productive effort about at present levels," and we shall be saying to the producers of equipment for the ground Army, "Cut down production."

America can no longer afford to think of war production as a single problem. People must realize that over-all war production consists of a number of distinct programs, some of which will continue to rise while others are reduced. One program reaches its peak long before another; and in modern warfare, with constant changes in battle requirements, production must always be kept flexible and must follow the trends of military action. The fact that a number of programs go downhill while others still go up is a healthy sign of the ability to meet the ever-changing requirements of total war. Comparisons of various programs are shown in accompanying charts.

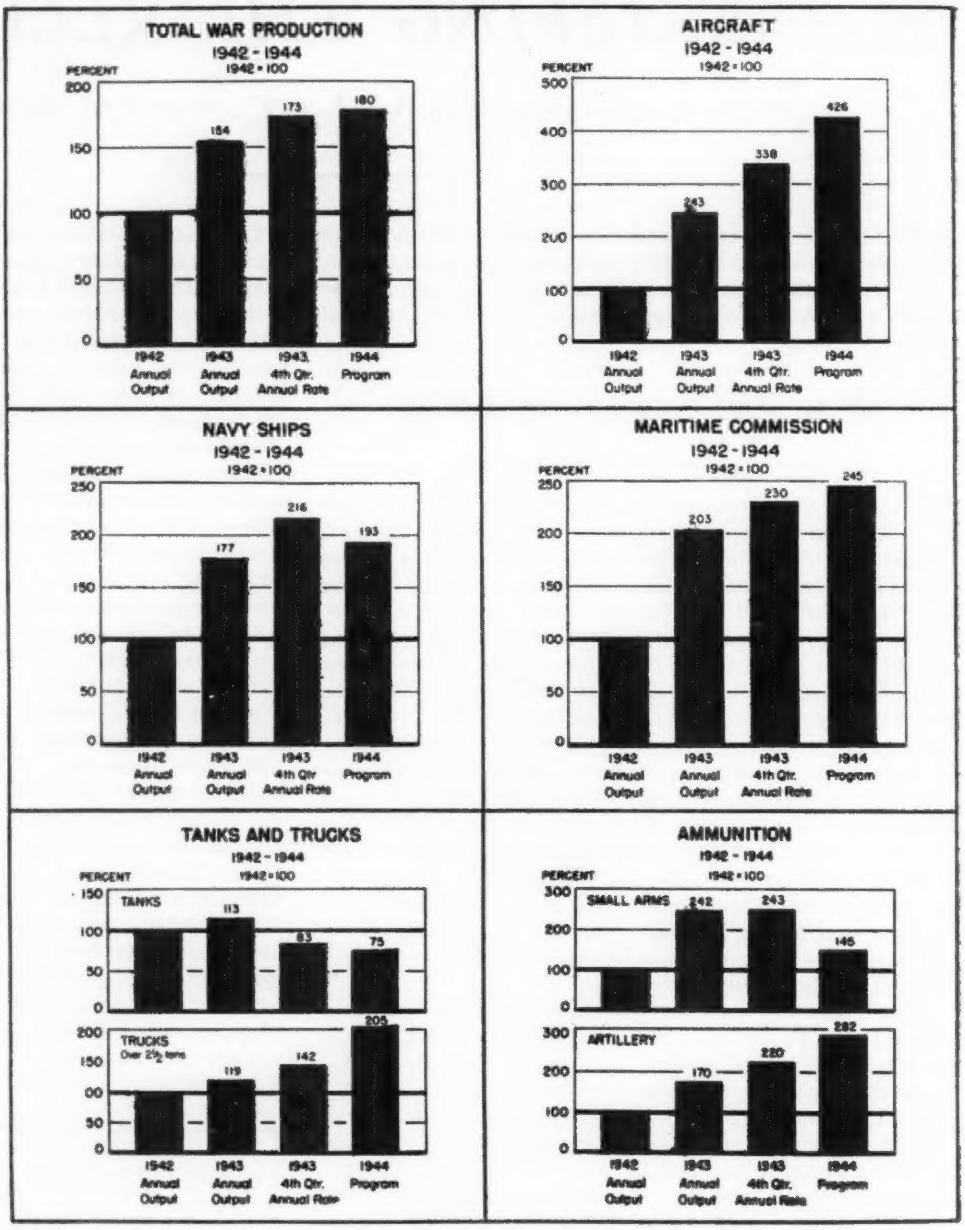
In my view, although American industry will have the task of carrying out the production program, the fulfillment of that



[1] Extracts from an address by Charles E. Wilson, Vice-Chairman, W.P.B., before the National Association of Manufacturers, at New York, N. Y., Dec. 15, 1943.

task by no means ends our responsibility to the nation in 1944. There is another responsibility that I consider equally important. Spiritual or psychological responsibility is easy to evade —for who is there to check up on us? For that very reason, because we answer to no one but ourselves for our influence upon the spirit of the nation, our responsibility is the greater.

I know of no other period in American history, except perhaps the Civil War, when there has been so much need for unity in our country, and so few signs of it, as at the present time. From where I sit in Washington it is an appalling thing to see the separate groups and special interests and cliques and special interests separating out of the main body of the American war effort in order to work for their own special purposes and private ambitions. Too many of us, I fear, have lost sight of our real goals and purposes in this war. Too many people are trying to position themselves for the postwar period long before the country is out of danger and long before our fighting men have any chance to position themselves.



Some of these special political and economic groups want to win complete victory for themselves regardless of the consequences for others and for the nation. Each group carries with it its own peculiar set of prejudices and hates and political pressures. Sometimes these groups can be made to see reason—sometimes they can be browbeaten into co-operation—but by and large they represent a serious menace to the unity of the nation, to the war effort, and to the lives and futures of American fighting men.

This above all is a time when the industrial leaders of America owe it to their country and to themselves to exercise temperate judgment—to practice the arts of compromise—to avoid the temptation of sacrificing enduring values for temporary gains—and to withhold encouragement from dangerous men who preach disunity.

What to Do About Absenteeism

WAR ADVERTISING COUNCIL

HOW industry can co-operate with the government to cut down absenteeism and reduce war-production casualties are subjects of two booklets recently published by the War Advertising Council. Job absences, it is pointed out, are a serious threat to the country's war effort. Absenteeism has slowed down not only direct war production, but almost all war-connected work. Estimates as to the number of hours lost, the national absence rate, etc. vary widely. The figures most frequently quoted are a war absence rate of 6 to 9 per cent against a peacetime rate of $3^1/_2$ to 4 per cent—but these figures cannot be taken too seriously. The chief reason for this is that there has been no standard method for calculating absenteeism. One plant uses as a base all absences, whether excused or not; another, only unexcused absences, etc.

Hundreds of plant and community reports, however, point to the fact that absenteeism is a dangerous war cancer which cannot be ignored. And they point equally to the fact that to attack it without knowledge of its causes is meaningless, and is usually doomed to failure. There are no uniform causes. Reasons for job absences vary from city to city, from industry to industry, and even between similar plants in the same locality.

If absenteeism is to be reduced, it must be understood. There must be a common, co-ordinated approach to the problem. The booklet lists various causes of absenteeism, such as illness, accidents, transportation difficulties, housekeeping problems, etc. and makes suggestions as to what can be done to correct such situations.

Casualties on the production front are rising, according to the

second booklet. If industrial accidents continue to increase at the present rate, 22,000 workers will be killed and 120,000 permanently injured in 1943, and 2,400,000 more will suffer accidents that will keep them off the job for about 16 days, resulting in a direct loss of some 49,000,000 days of work during the year. America at war cannot afford this tremendous loss of productive manpower. Job accidents are second only to sickness in the causes of absenteeism—yet most accidents can be prevented and are being prevented where management has adopted a proper safety program.

Industrial Relations[2]

THE ENGINEERING JOURNAL

PEOPLE even in this machine age have a large place in industry, and as human beings they are distinctly different, in kind, from the machines with which they are necessarily associated. It is true that the people in industry are not a homogeneous body. They may be classified in various ways —men and women—skilled and unskilled—supervisors and wage earners—management and workers—employers and employees. Regardless of the scheme of classification, their interests point in the same direction, the success of the undertaking.

Where satisfactory relationships exist, co-operation dominates the attitudes of the employer and the employee groups to each other. The two groups come together, in good faith, for discussion and consultation, to deal with those problems affecting their welfare and the success of the undertaking.

Good industrial relationships will not develop spontaneously in a plant. Some group must assume the leadership and undertake to direct and to educate both employer and employee in these matters. It is proper that the board of directors assume this responsibility, bearing in mind that it guides and directs a body of opinion and that it has no place as a dictator in a situation where democratic principles hold sway.

A SUGGESTED POLICY

In this situation we are led to adopt a definite policy that will govern our participation in employer-employee relationships, a policy which we will carry out in such a way that every supervisor, every manager, and every operating executive will feel that he has a part to play in establishing and maintaining proper industrial relations, and to which we will insist that each adhere scrupulously.

A

(1) It will be our practice to provide our employees with "fair" wages, promptly and regularly paid for "reasonable" hours of work. We will provide "good" working conditions, careful supervision, as stable employment as business will permit, and every opportunity for advancement on merit.

(2) We will allow no discrimination against an employee on account of race, nationality, religious or political affiliations, or membership or nonmembership in a lawful labor organization.

(3) We will encourage our employees to take an interest in the business and in management problems by offering rewards for constructive suggestions.

(4) We will deal and negotiate in good faith with the lawful organization that represents our employees.

(5) In co-operation with our employees we will institute such plans for employee security as the prosperity of the business permits.

[2] Abstract of an address by J. L. Cameron, Professor of Commerce and head of the Industrial Relations Section, Queen's University, Kingston, Ont., delivered at a joint meeting of the A.S.M.E. and The Engineering Institute of Canada at Toronto, Oct. 2, 1943

B

We cannot fulfill our obligations to our employees unless they, for their part, recognize and fulfill certain obligations to us.

(1) We will expect them to demonstrate their loyalty to the business by supporting the management in its efforts to maintain, improve, and expand the business.

(2) We expect them to co-operate with fellow workers and with the management, through the regular channels, for discussion and solution of the problems that arise in the course of our operations.

(3) They ought to treat as confidential all information regarding our business and ought to carefully avoid passing on to competitors anything that might be injurious to us.

(4) They ought to give good workmanship and careful attention to the job in hand.

(5) They must obey promptly all reasonable rules and orders, including those regarding punctual and regular attendance, sobriety, restriction of smoking, safety practices, good housekeeping, and personal cleanliness.

C

We will bargain collectively with our employees, if they desire it, through the lawful agency which represents them. We will negotiate with them in good faith, doing our utmost to arrive at a collective labor agreement—an agreement which will set out as clearly as possible the duties, responsibilities, rights, privileges, and immunities of both parties.

We believe that the agreement, to be effective, should cover certain important questions.

(1) It should explicitly indicate the bargaining agency and it should define the extent of its recognition.

(2) It should guarantee the rights of management to operate the business safely and efficiently and to direct and discipline the working force.

(3) It should give the employees the right to appeal to management if they believed that the rights of management have been unjustly exercised.

(4) It should provide machinery for the discussion and the solution of problems and for the settlement of grievances arising out of the agreement.

(5) It should make provision that, if the parties fail to arrive at a mutually satisfactory decision on any matter arising out of the agreement, it should be referred to a board of arbitration whose decisions should be final and binding on both parties.

(6) Both parties should agree to accept the existing scale of wages direct and indirect, subject to such modifications or changes as are allowed or ordered by the national or regional war labor board.

(7) The regular hours of work and the rates of pay for overtime on regular working days as well as on Sundays and legal holidays should be set out.

(8) There should be a provision for vacations with pay for hourly workers, but the granting of such vacations should be dependent upon regular attendance.

(9) It should be agreed that in case of layoffs, transfers, rehirings, or promotions, competence shall be the governing factor, but that seniority shall be given due consideration. It should be clearly understood that the management is the sole judge of the competence of the employees. The seniority of all employees who have gone into the armed forces should be preserved and protected.

(10) There should be a guarantee that members of the bargaining agency shall be free to discharge their duties to that agency without fear that their relations with the company will be affected in any way. (It should be understood, however, that the bargaining agency's business must be done in working hours or on the company's premises only to the extent specifically allowed in the agreement.)

(11) There should be a provision under which the company

guarantees to protect, by every reasonable means, the safety and health of its employees during the hours of their employment. The extent to which the company provides personal necessities, such as hard hats, hard-toed shoes, gloves, overalls, rubber aprons, rubber boots, etc., should be clearly defined.

(12) It should be agreed that so long as the agreement remains in force and the parties are living up to their promises, there shall be no lockout by the company, nor shall there be any strike, slowdown, sit-down, or suspension of work, either complete or partial, by employees.

(13) The agreement should be for a reasonably long period of time, for its object is to maintain as well as to establish industrial peace.

D

It will be our policy to protect the interests of all lawful bargaining agencies and to oppose the efforts of any group which, by subterfuge, misrepresentation, coercion, or other objectionable methods, is seeking to strengthen itself at the expense of any other lawful bargaining agency or group of employees.

However, we do not consider it in the best interests of the business to deal with more than one collective-bargaining agency in a single establishment, unless the interests of others are so divergent as to require separate treatment.

When we have bargained in good faith and have entered into an agreement with a collective-bargaining agency, and when there is no question about our willingness to live up to the terms, we think it is highly improper that we should be punished for the alleged sins of some other employer by means of a sympathetic strike of our employees. We therefore favor legislation under which a collective-bargaining agency will be deprived of its bargaining rights for a period of at least one year when an appropriate judicial body has convicted it of authorizing, promoting, or encouraging a sympathetic strike.

CONCLUSION

I suggest that in handling industrial problems it is part of your job to study trends in social thinking, noting both the direction and rate of growth, so that you may apprise your directors of the significance of the trends and suggest what steps should be taken in matters of industrial leadership. In the years that lie ahead will you pioneer a new order of human relationships or will you be content to make your policy from day to day as necessity demands? I hope that you will adopt the former course and, as a first step, I suggest that you write out for your own guidance, if for no other reason, the code of ethics which you think should be adopted.

Railroads in Wartime

1943 YEARBOOK OF RAILROAD INFORMATION

THE full story of the part played by the railroads in our war activities cannot yet be told, but the War Department has released certain figures which indicate how great and how important the railroads' war service has been. Between Dec. 7, 1941, and May 31, 1943, more than 20 million troops were moved by railroad. The average journey of these men was about 850 miles. More than 80 million tons of army freight and express shipments were moved by the railroads.

During the first five months of 1943 the total volume of freight transported, according to the "Yearbook of Railroad Information," was 15.3 per cent above the same period of 1942. Passenger traffic was up 43.5 per cent. The ton-miles of freight transported was the greatest in the history of American railroads, as was the passenger-miles of transportation rendered.

This job was done with about 38,000 passenger-train cars, as compared with 52,000 during World War I, 42,000 locomotives as compared with 61,000, and 1,745,000 freight cars as compared with 2,253,000 during World War I.

Salvage Manual for Industry

WAR PRODUCTION BOARD

A COMPREHENSIVE, practical manual on industrial salvage has been published by the Technical Service Section, Industrial Salvage Branch, Salvage Division, War Production Board, and is now being distributed to industry. It contains 245 pages of systematically organized and classified information and data—most of it of a "how-to-do-it" nature—on industrial salvage practice in all its ramifications. Material is presented in 26 chapters, grouped into 6 major sections. There are 2 chapters on organizing and planning the salvage department; 3 on the administrative factors; 12 on methods of handling (finding, identifying, segregating, collecting, reclaiming, storing, selling, etc.) metal scrap; 3 on nonmetallic waste; 7 case histories demonstrating exemplary practice; a 17-page compilation of practical hints for handling specific waste materials; and a 9-page index. Section 6, "Waste Materials Hints," is based on the "Waste Materials Dictionary," published several years ago by the A.S.M.E.

Types of Synthetic Rubber

UNITED STATES RUBBER CO.

PROPERTIES of various kinds of synthetic rubber are outlined in a booklet prepared by the United States Rubber Company. The discovery of a man-made substitute for natural rubber, it is pointed out, is one of the greatest triumphs of chemistry. For generations it had been considered an impossibility.

Synthetic rubber is not the development of any one man, or of any one nation. Over a period of 70 years, important contributions were made by prominent chemists of Great Britain, France, Germany, Russia, and the United States. In 1826, Michael Faraday showed that natural rubber was composed of five atoms of carbon and eight atoms of hydrogen and was therefore a hydrocarbon. Other familiar hydrocarbons are gasoline, kerosene, turpentine, lubricating and fuel oils, benzene, and natural gas. In 1860, Grenville Williams, an Englishman, broke down natural rubber by heat and derived from it a liquid which had the same chemical composition as rubber, C_5H_8. He called it isoprene.

G. Bouchardat, a Frenchman, while experimenting with isoprene, in 1879, obtained a substance which had elasticity and some of the other properties of rubber. Bouchardat was the first to suggest the important conception that rubber is a polymer, a substance in which the original molecules have linked together to form giant molecules.

In 1892, Sir William Tilden, an Englishman who first determined the specific heat of many elements, made isoprene from turpentine and let it stand in a bottle. Large yellow pieces formed. They somewhat resembled rubber, but were useless. However, this was the first time that a rubber-like material had been made from other materials. And this may be called the first of many attempts to make rubber in a laboratory. Many other experimenters followed in their footsteps until five types of commercial synthetic rubber had been developed.

(1) *The buna-S type*, a co-polymer of butadiene, C_4H_6, and styrene, $C_2H_3(C_6H_5)$. This type was chosen for the major part of the synthetic program for the war. The S refers to styrene. United States Rubber Company had built and was operating a pilot plant producing buna-S in March, 1941. Large, additional buna-S plants are being built and will be operated for the government by U. S. Rubber Company, Firestone, Goodrich, and Goodyear.

(2) *The buna-N type*, co-polymers of butadiene and acrylo-

TABLE 1 COMPARATIVE PROPERTIES

Properties important in processing	Natural rubber	Buna-S types	Buna-N types	Neoprene types	Butyl types	Thiokol Polysulphide types
Form in which available:..........	Latex and solid forms	Latex and solid forms	Latex and solid forms	Latex and solid forms	Solid form	Dispersion, solid, and powder forms
Breakdown....................	Very good	Good	Fair	Good-very good	None	Slow
Plasticity range after breakdown	High-low	High-low	High-medium	High-low	Medium	High-low
Building tack and cohesion.....	Excellent	Fair	Fair	Very good	Good	Fair-good
Vulcanizability................	Very good	Very good	Very good	Very good	Fair-good	Fair
General processibility..........	Very good	Good	Fair	Good	Fair	Fair
Properties important in application:						
Physical properties						
Extensibility..................	Excellent	Good	Good	Excellent	Excellent	Good
Resilience.....................	Excellent	Good	Fair-Good	Very good	Low	Good
Tensile........................	Excellent	Fair-good	Good	Very good	Good	Fair
Electrical properties............	Excellent	Excellent	Fair	Fair	Excellent	Fair
Impermeability to gases........	Good	Good	Good	Very good	Excellent	Excellent
Impermeability to water........	Good-very good	Fair-good	Fair-good	Fair-good	Very good	Very good
Resistance to:						
Plastic flow...................	Very good	Good	Good	Good	Fair-good	Low
Abrasion......................	Very good	Good-very good	Good-very good	Very good	Fair	Low
Tear..........................	Very good	Fair-good	Fair-good	Good	Fair-very good	Fair-good
Heat..........................	Good	Fair-very good	Fair-very good	Very good	Fair	Low
Cold..........................	Very good	Very good	Fair-good	Fair-very good	Good	Fair-good
Chemical properties						
Resistance to:						
Air...........................	Fair	Good	Good	Excellent	Excellent	Excellent
Ozone.........................	Inadequate	Inadequate	Fair	Excellent	Excellent	Excellent
Light.........................	Fair	Fair	Low	Excellent	Excellent	Excellent
Petroleum.....................	Low	Low	Excellent	Good	Low	Excellent
Aromatic oils.................	Inadequate	Inadequate	Fair	Low	Inadequate	Excellent

nitrile, or vinylcyanide, C_2H_3CN. The N refers to the nitrile or cyanide radical.

The buna-N type synthetic rubbers include the following: Perbunan, Standard Oil Company (New Jersey) and The Firestone Tire & Rubber Company; Hycar, Hycar Chemical Company, owned by Phillips Petroleum Company and The B. F. Goodrich Company; Chemigum, The Goodyear Tire and Rubber Company; Thiokol *RD*, Thiokol Corporation, associated with The Dow Chemical Company.

(3) *The neoprenes*, polymers of chloroprene, C_4H_5Cl, developed by DuPont Co.

(4) *Butyl rubber*, a co-polymer of isobutylene, C_4H_8, and small amounts of other unsaturated hydrocarbons such as butadiene, C_4H_6, or isoprene, C_5H_8. Butyl rubber and Flexon, called "bathtub butyl" because it can be made with comparatively simple equipment, are developments of Standard Oil of New Jersey.

(5) *The Thiokols A, B, and FA* are made from ethylene di chloride and sodium tetrasulphide; or dichloroethyl ether and sodium tetrasulphide; or combinations and modifications of the two. They were developed by Thiokol Corporation and are now being manufactured by Dow Chemical Company for Thiokol Corporation.

The characteristics of the different types are shown in the accompanying Table 1.

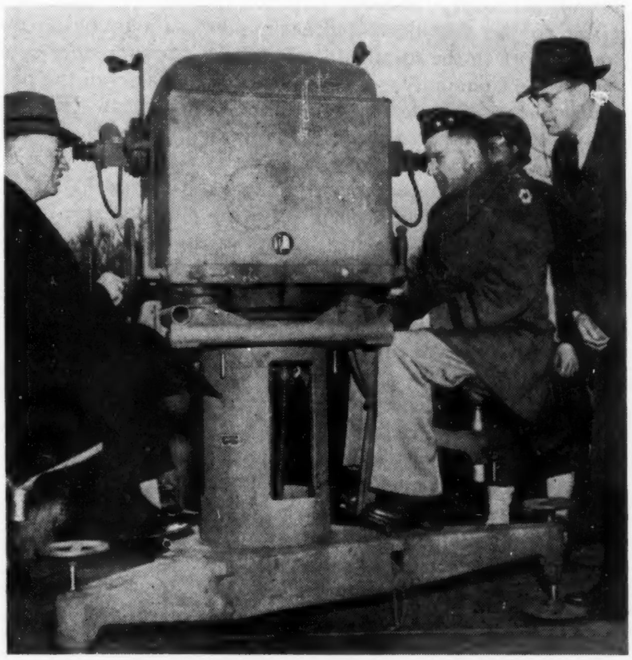
Antiaircraft Tracker

GRAHAM TRANSMISSIONS, INC.

WITH restrictions partially lifted on the army's new M9 antiaircraft gun director, it can now be revealed that its uncanny tracking device relies on a pair of mechanical-type variable-speed transmissions for accuracy in following the flight of enemy aircraft. Two modified Model 25 Graham built drives are used, one to rotate the tracker in azimuth and the other to control elevation.

Two soldiers sit at the telescopes of the tracker, which is mounted on a motor-driven revolving table. As one man sights the approaching aircraft in azimuth with his control wheel, the other moves a similar wheel to line up the plane for elevation. Each operator follows the enemy flier in his sights, with the two Graham built units matching the speed of the target. Close speed holding is required over a wide range, forward and reverse, with a need for considerable operation without wobbling in the neighborhood of zero. Instantaneous, shockless reversal without stopping the motor is essential.

Besides a tracker, the M9 gun director consists of an electrical computer and a range finder, each a separate unit co-ordinated with the other to create an "electric brain" which eliminates human variables. It tracks the plane, automatically calculates the lead of the guns to suit the individual conditions, aims and follows the flight electrically.



TRACKER UNIT OF M9 ANTIAIRCRAFT GUN DIRECTOR DURING DEMONSTRATION

(Oliver E. Buckley, *left*, president of Bell Telephone Laboratories, and Maj. Gen. L. H. Campbell, Jr., chief of U. S. Army Ordnance Department, operate the unit. Standing is Dr. David R. Parkinson, physicist of the Bell staff, originator of the idea.)

COMMENTS ON PAPERS

Including Letters From Readers on Miscellaneous Subjects

Women Workers

To the Editor:

For me, the central figure in Mr. Tuttle's article[1] is the woman who "kept a mallet handy" beside her machine and, instead of using her hand for a crank to clamp parts for milling on the moving table, and again to release the milled part, "picked up the mallet and rapped the crank handle a sharp blow in order to loosen it." Observation of her device led to the invention of a new automatic mill vise, faster than the old crank.

The worker at the bench, whether man or woman, has the experience from which management, if alert to the possibilities of labor-management co-operation, can develop new methods to facilitate production for the benefit both of the worker and the management.

This conclusion, however, is not drawn in Mr. Tuttle's article. Evidently in his company, management is alert to observe and to seek to develop conditions which will enable newly employed women workers to do their job well. The discovery that women workers themselves will be the best advisers for management is not indicated. Instead, emphasis is given to the new development in personnel work in the so-called "counseling service." Unhappily, it was a disciplinary need which led to it in this company. A matron was needed to prevent the girls from lounging too long in the rest room. The counselors, beginning as matrons, took on their tasks in adjusting women to production work, but it was a process from the top, and it arose not in the spirit of co-operation nor out of recognition of the contribution which the worker has to make to workshop methods.

Central in experience in the last war, when the Ordnance Department and subsequently the Women's Bureau in the Department of Labor developed standards for employment, was the emphasis upon channels of communication through workshop committees, whereby workers could make their contribution to the most effective productivity for the war. In subsequent years efficient managers have learned the value of union-management co-operation; and the spread of unionization, in which women are taking a notable part, makes it possible today to deal with problems of introduction of women into industry by this kind of democratic procedure.

Allied with it must be the promotion of women to higher positions, including their places in personnel departments. Simultaneously with Mr. Tuttle's article, there came to my desk the ***Labor Information Bulletin*** of the Department of Labor for September, with an article on women's employment in professional or technical jobs. Women will become competent workers more rapidly if recognition of their capacity is demonstrated in the promotion of women as a settled policy.

In the mobilization of manpower, this recognition of women workers and acceptance of them at all levels of work and management is of the utmost importance.

Mary van Kleeck.[2]

[1] "Women Who Work for Victory," by W. G. Tuttle, Mechanical Engineering, September, 1943, pp. 657–660.

[2] Director, Department of Industrial Studies, Russell Sage Foundation, New York, N. Y.; formerly, director Women's Branch of Industrial Service Section of U. S. Ordnance Department, 1917–1918; director Woman in Industry Service (now Women's Bureau) U. S. Department of Labor, 1918-1919.

Creative Freedom and Engineers

To the Editor:

The war has brought with it the need for re-evaluation of the very foundations of our civilization. Statesmen of the opposing sides sought the support of the masses of the population behind such divergent philosophies of existence as domination of the weak by the strong, or the meek by the arrogant, and the freedom of individual development of every nation able to claim an independent concept for its own happiness. Domination in any form is a thoroughly discredited basis for human happiness and countless modifications of it can be found in the scrap piles of former civilizations out of which freedom's seeds continued to sprout. In the blood shed in the French and American revolutions freedom became recognized as the foundation of modern society.

The latest attempt to enslave the world by the race of "supermen" resulted in the proclamation of the four freedoms—freedom of worship, freedom of speech, freedom from fear, and freedom from want. The war is being fought and thousands of lives are being sacrificed to establish these four freedoms for posterity. We have every reason to believe the war will be won. The task of establishing these four freedoms on a more secure basis than heretofore may therefore be discussed.

Engineers without a doubt will play an outstanding role in the postwar world because no other group of human society excels engineers in creative urge. Civilization owes much to engineers who have proudly proclaimed "give me a point of support and I will lift the earth" and "what is not yet may be." Individual enterprise is the chief characteristic of an engineer worthy of his name, and the history of engineering is the composite story of individual engineers. The motives which inspire engineers may differ. In some, it is material gain or the attraction of power. In most, it is the mere joy of achievement. Whether they benefit themselves is of secondary importance as long as their labors benefit mankind.

The equipment of the engineer is his knowledge of fundamental natural laws and confidence in the infallibility of logic. In short, he is the most rational of men. He is the pioneer in the truest sense of the word. The coming postwar era will require a lot of pioneering, a lot of creative effort by engineers. And what is America except a colossal monument to the self-reliance, ingenuity, and intrepidity of engineers who labored prodigiously, failed frequently, but overcame countless obstacles in the end and created a unique, mechanized, but free and happy land?

The engineer epitomizes the force of the individual human personality; he is the embodiment of independence and self-reliance; he is truly the earthly deputy of the Almighty Creator; he leads on to happiness of a purposeful life for all. Let nothing interfere with the freedom to create that is the birthright of every individual engineer.

E. C. Magdeburger.[3]

[3] Bureau of Ships, Navy Department, Washington, D. C. Mem. A.S.M.E.

Correction

On page 824 of the November, 1943, issue of Mechanical Engineering, the formula at the bottom of the first column in the comment by J. F. Brennan (Lieut. U.S.N.R.), should *not* have a minus sign before the last *g*.

A.S.M.E. NEWS

And Notes on Other Engineering Activities

A.S.M.E. 1944 Spring Meeting to Be Held at Birmingham, the "Industrial City Beautiful"

IT WAS indeed a fortunate choice when Birmingham, Ala., the "Industrial City Beautiful," was selected at which to hold the 1944 Spring Meeting of The American Society of Mechanical Engineers, April 3 to 5.

Birmingham is particularly beautiful in the spring and is celebrated for its friendly mountains and broad drives, bridle paths, and rustic walks, dogwood trails, and rose-lined highways, wide streets and easy traffic, handsome homes and landscaped grounds, a city famous for a scenic setting seldom seen in metropolitan centers. In the center is the city proper, boasting an intersection which is among the "heaviest" in the world because a skyscraper stands on each corner, claiming also modern stores, handsome public buildings, many well-equipped hotels. They say in Birmingham that it is the heart of Dixie and the soul of southern hospitality—a deep South city of beauty.

Centrally Located

While in general this meeting is expected to draw its attendance largely from the Southeast, nevertheless Birmingham is so centrally situated on the main line for air and rail travel that many members from other localities are expected to take the opportunity of attending a national meeting of the A.S.M.E. with a program covering so wide a field of technical interest. In these wartimes it is of more importance than ever that members of the Society keep immediately abreast of the newest developments in their respective industries and nowhere can that be done as successfully as at a national meeting where papers of direct interest to war and postwar activities are presented and earnestly discussed. These are the meetings that one is actually afraid to miss, so fast do the new techniques spring up and mature.

Sessions in Many Fields

The program was broadly outlined during the 1943 Annual Meeting when it was decided that sessions would be sponsored by Process Industries, Aviation, Power, Fuels, Management, Hydraulic, Industrial Instruments and Regulators Divisions, and the Research Committee on Metal Cutting.

The Birmingham Section is also developing certain features of the program and R. A. Polglaze, former chairman of the Section, will present a paper on the "Water Supply of Alabama." Another paper under consideration by the Section will deal with the centrifugal casting of steel, one of the leading industries of Birmingham.

The complete program for the Spring Meeting will be published in the March issue of MECHANICAL ENGINEERING and an announcement containing full information regarding the meeting will be sent to members living in the Southeast. Members in other parts of the country who are interested in the details of the meeting may secure full information about it by writing to the Secretary's office.

Make Hotel and Rail Reservations Early

Official headquarters for the Meeting will be at the Hotel Tutwiler which has adequate facilities for handling a gathering of this character. It cannot be stressed too strongly, however, that room reservations should be made early. If the capacity of the headquarters hotel is exceeded there will still be time to take care of the overflow in other near-by hotels.

When room reservations are made it will be wise to make rail reservations at the same time with your railroad agent. All transportation reservations should be made before the end of February surely. So decide now to go to Birmingham if it is at all possible, first because it is going to be a corking good meeting technically, and second because it is one of the loveliest spots in the United States in the spring.

See Page 145 of This Issue!

Your attention is particularly called to page 145 of this issue on which appear the names of all of the members of the A.S.M.E. Nominating Committee for 1944 with their addresses and the Groups they represent.

Read the request of the Committee which urges you to suggest nominees for office in the A.S.M.E. in 1944. Suitable forms will be furnished by the Committee on request.

A.S.M.E. Professional Group on Consulting Practice Organized

Objectives Stated and Committees Formed

THE meeting held on Dec. 1, 1943, marked the end of the Committee on Consulting Practice appointed by Past-President McBryde several years ago. It also marked the beginning of the Professional Group on Consulting Practice, as authorized by the Executive Committee of the Council of The American Society of Mechanical Engineers. The history of this activity was outlined by the chairman of the committee, who is also the chairman of the professional group.

In accordance with the instructions of the Council and the regulations covering the organization and management of professional groups and professional divisions, an executive committee has been organized, consisting of the following:

- S. Logan Kerr, chairman and member of the executive committee for one year
- M. X. Wilberding, member of the executive committee for two years
- Paul L. Battey, member of the executive committee for three years
- Warren McBryde, member of the executive committee for four years
- Frank H. Prouty, member of the executive committee for five years.

Objectives

One of the aims and objectives of this Professional Group on Consulting Practice is to provide a meeting place for discussion and comment within The American Society of Mechanical Engineers for those members of the Society who are engaged in or interested in consulting mechanical-engineering problems. None of the organizations, such as the State or National associations of professional engineers or the American Institute of Consulting Engineers, provides a common meeting place for the diverse interests of mechanical engineers.

Another objective of this group is to organize an educational program on the cost of rendering consulting services, whether it be for individual consulting or for the design and carrying out of projects. This program also includes the study and preparation of suggested contract forms to be used to cover the business relationship between consultants and their clients.

At least once each year, there will be scheduled a consultants' conference, at which time the Executive Committee of the Professional Group on Consulting Practice will report on the development of the previous year and will

A.S.M.E. Calendar

of Coming Meetings

April 3-5, 1944
A.S.M.E. Spring Meeting
Birmingham, Ala.

May 8-10, 1944
A.S.M.E. Oil and Gas Power Division Meeting
Tulsa, Okla.

June 19-22, 1944
A.S.M.E. Semi-Annual Meeting
Pittsburgh, Pa

October 2-5, 1944
A.S.M.E. Fall Meeting
Cincinnati, Ohio

November 27-December 1, 1944
A.S.M.E. Annual Meeting
New York, N. Y.

(For coming meetings of other organizations see page 34 of the advertising section of this issue)

also arrange to have papers presented on subjects of particular interest to those who are concerned with rendering consulting-engineering services.

Committees

The program is to be implemented by four committees to be appointed by the Executive Committee:

(1) *Committee on Manual of Practice.* This committee will be charged with the review and revisions, when needed, of the Manual of Practice, which was published by the Society several years ago. If suggestions come from the membership, they will be reviewed by the committee and prepared in the form of recommendations for the approval of the Executive Committee. By this means, the Manual of Practice can be kept up to date and made of more general value.

(2) *Committee on the Cost of Consulting Engineering Services.* This committee will be headed by M. X. Wilberding, to cover a complete study of the elements entering into the cost of consulting-engineering services, together with suggested methods of cost keeping and accounting, with a view to making this activity of consultants more uniform than it has been in the past. When the committee has completed its report, the Executive Committee plans to have the report published as a supplement to the Manual of Practice.

(3) *Committee on Recommended Contract Forms.* This committee will be headed by Frank H. Prouty and is to draw up recommended contract forms for each of the various types of consulting services rendered and submit them to the Executive Committee for review. It is expected that this committee's report will be published as a supplement to the Manual of Practice.

(4) *Committee on Co-Operation With State and National Organizations of Consultants and Registered Professional Engineers.* There are a number of State and National organizations of registered professional engineers, who are preparing and publishing codes of ethics, recommended scales of fees and compensation, and similar matters, in which the consulting mechanical engineers have a definite interest. There are national societies, such as the American Institute of Consulting Engineers, who have prepared similar documents. It is the purpose of this committee to co-operate with these other organizations and keep them advised from time to time of the work which the Professional Group on Consulting Practice of The American Society of Mechanical Engineers is doing.

Paper on Costs Discussed

The general discussion which followed the chairman's report was participated in by a number of those present. M. X. Wilberding presented a paper entitled, "The Costs of Rendering Consulting Engineering Services," which was discussed at length by a number of those present. Past-President McBryde gave a brief summary of the status of consultants when retained by the Federal Government and the problems and limitations encountered with respect to adequate fees.

The opinion was expressed by several that the Professional Group on Consulting Practice could appropriately undertake to improve the public relations existing between the consultants and the public as a whole, and to bring about a better understanding of the value of services rendered by consultants. There was considerable discussion about the portion of the cost of consulting services which is now lumped under a general term and designated as overhead. It is felt that the committee on costs will have some constructive suggestions in this regard.

The initial meeting of the Professional Group indicated that there was considerable interest in the problems of the consulting mechanical engineer and that increased activity in the discussion of these problems, as provided by the Professional Group just organized, would undoubtedly be helpful and constructive.—S. LOGAN KERR.

E.I.C. and A.S.M.E. Sign Co-Operative Agreement

ANNOUNCEMENT of the signing of a co-operative agreement between The Engineering Institute of Canada and The American Society of Mechanical Engineers appeared in MECHANICAL ENGINEERING for January, 1944, page 81. The subjoined report of the recommendations to the Councils of the two Societies, by a joint conference of representatives of both bodies, constitutes the text of the agreement.

I Introduction

Accredited representatives of The Engineering Institute of Canada and The American Society of Mechanical Engineers met in New York on August 23, 1943, to consider steps to be taken to develop the cordial relationships for over thirty years between the two Societies into a program of active co-operation. This unanimous report, which resulted from the conference, is presented to the two Councils with the request that its recommendations be adopted as a first step in the development of a tradition for working together that may have far-reaching influence in enhancing the effectiveness of the professions in both nations.

II Premises

The Engineering Institute of Canada is the only all-embracing, purely engineering national society in Canada and has a co-operative interchange of memberships and other privileges with four of the eight provincial associations (the licensing bodies) of Canada. It has about 200 members in the United States.

The American Society of Mechanical Engineers, devoting itself to the mechanical specialty of engineering, has about 285 members in Canada, a Local Section, styled the Ontario Section, with headquarters at Toronto, and three Student Branches, at the University of Toronto, Queen's University, and the University of British Columbia.

The relations between the two bodies cover a wide field. A joint meeting is to be held in Toronto, September 30 through October 2, 1943. This is the first joint affair in the history of the two bodies—a previous venture, the 1939 British American Engineering Congress having been abandoned because of the war A.S.M.E. Sections and E.I.C. Branches have held joint meetings in Toronto and at border points. A.S.M.E. has elected two residents of Canada to its Council and has conferred honorary membership on three distinguished engineers of Canada. A fourth honorary membership is to be conferred at Toronto on October 1, 1943. Both secretaries are members of both bodies. Members of E.I.C. are privileged to purchase A.S.M.E. publications at member's rates. E.I.C. is a member body of the Engineers' Council for Professional Development, which brings its representatives into frequent friendly contact with the A.S.M.E. representatives. From time to time Canadian engineers have participated in the meetings and technical-committee work of A.S.M.E. and engineers from the United States have appeared before E.I.C.

During the war, intimate co-operation has prevailed in research between engineers and scientists in Canada and the United States. The technical advances brought about by the war and the possibilities of engineering development after the war provide a fertile field for active co-operation between the two Societies.

The cordial working relation between the two Societies and the engineers of the two nations points to the desirability of an active program of co-operation, keeping in mind that, first, each Society has much to give and gain by co-operation which must be to the mutual interest of both and, second, the engineer's first loyalty must be to his own national body.

III Recommendations

The recommendations of the Joint Conference are in two parts: First, those on which immediate action seems wise and, second, the establishment of a continuing agency for implementing further co-operation with a list of items this agency may find it expedient to consider.

A—Immediate Action

The joint Conference recommends that the Councils of The Engineering Institute of

Canada and The American Society of Mechanical Engineers take the following parallel actions, the actions to be finalized only where both bodies concur; and publicity to be withheld until both concur.

1 *Meetings*

Recognizing the importance of the interchange of experience, each Society authorize the appointment of representatives to confer at least annually about possible opportunities for useful joint meetings and the invitation of members of each Society to meetings of the other.

2 *Local Organizations*

(*a*) Each Society adopt the policy of instituting a local organization of members in the country of the other after conference with the proper body of that country and after painstaking study of alternative co-operative means of providing the service that would normally be given by such a local organization.

(*b*) Each Society express the preference that the officers of a local organization be citizens of the country and members of a national engineering society of the country in which the local organization is located.

(*c*) Each Society encourage joint meetings between contiguous A.S.M.E. Sections and E.I.C. Branches and the formalization of continuing co-operative contacts between them.

3 *Student Organizations*

Each Society adopt the policy of establishing a student organization in the country of the other after conference with the proper body of that country and after painstaking study of alternative co-operative means of providing the service that would normally be given by such a student organization.

4 *Secretaries' Membership*

As a public recognition of the desirability of continued intimate and cordial relations between the secretarial staffs of the two bodies, each Society elect the secretary of the other to membership without dues provided he meets the necessary membership qualifications.

B—Continuing Co-Operation

Each Society appoint three representatives, one if possible from the current membership of each Council, to a continuing Joint Conference which shall select its chairman and secretary and shall meet at least annually to review present co-operation, to seek means for further co-operation, and specifically to study and report on the following items.

1 Develop a comprehensive plan whereby students in mechanical engineering at all Canadian universities may participate in A.S.M.E. student activities through membership in the student organization of E.I.C.

2 Consider the possibilities of a plan for the interchange of membership privileges with a combined rate of dues.

3 Explore the plans and programs of the technical and program-making activities of each Society to determine: (*a*) whether they may be broadened to be of greater value to members of the other Society; (*b*) whether some form of member participation of one Society in the activity of the other may be useful to either or both, and (*c*) whether new joint research or other technical projects may be developed to be of mutual value to mechanical engineers of Canada and the United States.

IV Closure

The participants in the Joint Conference report their deep satisfaction in the splendid spirit of their discussions which they know will be continued in the permanent Joint Conference and will develop into a continuing program and tradition of great mutual value.

Respectfully submitted,

J. B. CHALLIS O. O. LEFEBVRE L. AUSTIN WRIGHT	*The Engineering Institute of Canada*
A. G. CHRISTIE J. W. PARKER C. B. PECK C. E. DAVIES	*The American Society of Mechanical Engineers*

October 1, 1943

A.S.M.E. Process Industries Division Organizes New Petroleum Committee

AT THE 1943 Annual Meeting of The American Society of Mechanical Engineers the A.S.M.E. Petroleum Division was temporarily returned to the supervision of the Process Industries Division where it is to be reorganized as a committee of that Division.

It is felt that a sufficiently large number of A.S.M.E. members are engaged in the petroleum and affiliated industries to make themselves felt in the Society through active participation in professional division activities.

The Process Industries Division is attempting to promote information on unit operations as pertaining to various industries. In this way, it believes it best serves the purpose of enabling one industry to benefit from the knowledge and experience of another. By crossing unit operation with industries much more is gained than if these are kept separate from each other. There are many unit operations used in petroleum processing which those in the field would like to know more about, and those of other industries benefit by hearing about them.

The Executive Committee of the Process Industries Division would like to receive suggestions from members as well as recommendations for appointment of a chairman for the Petroleum Committee. Until such appointment, the temporary chairman, William Raisch, will be pleased to receive material for presentation at meetings and for publication.

A.S.A. Holds Quarter-Century Anniversary

THE American Standards Association held its quarter-century meeting at the Hotel Roosevelt, New York, N. Y., on December 10.

It was announced that the Board of Directors of the Association had authorized participation in an Allied Nations Standards Body. The organization of such a body has been discussed informally for a number of weeks between the British Standards Institution, the Canadian Engineering Standards Association, the American Standards Association, and also with key governmental agencies in the three countries.

The function of the organization is to "spark-plug" co-operation between the allied belligerent countries in standardization matters as an aid to production and use.

The object is to secure the maximum possible co-ordination of standards necessary for the war and the immediate postwar period. A skeleton staff will be provided with offices in London and in either New York or Washington.

The meeting was marked by the presence of many former officers of the Association, as well as representatives of the trade and technical groups and government departments that hold membership in the A.S.A. and the O.P.A. and W.P.B. and the armed services for which it has recently carried on so much of its work. Percy Good, director of the British Standards Institution, brought the greetings of his organization to the meeting in person, and there were greetings from the national standardizing bodies of others of the United Nations.

Officers for 1944, as announced are:

President, Henry B. Bryans, executive vice-president, Philadelphia Electric Company.

Vice-President, George S. Case, chairman of board, Lamson and Sessions Company.

Chairman, Standards Council, H. S. Osborne, chief engineer, American Telephone & Telegraph Company.

Vice-Chairman, Standards Council, E. C. Crittenden, assistant director, National Bureau of Standards.

Clifton E. Mack, director of procurement, United States Treasury Department, and the man in charge of government lend-lease purchasing, was guest speaker at the meeting. Mr. Mack's address dealt with the use of standards to cut costs in government, and how standards are helping this country to deliver to our allies in sufficient quantity and in good condition the products that are helping to win the war.

R. E. Zimmerman, vice-president, U. S. Steel Corporation, and retiring president of the American Standards Association, spoke on postwar changes and developments in use of standards in this country and in international trade.

H. S. Osborne, chairman of the Standards Council, reported that in the past twelve months the American Standards Association had approved 119 standards.

Register Now in New

Industrial Instruments and Regulators Division

A NEW Division of The American Society of Mechanical Engineers will provide greater facilities for members of the Society to discuss developments within the very broad and rapidly expanding field encompassed by the terms—industrial instruments and regulators.

First as a Committee, more recently as a Group, this Division of the mechanical-engineering field has grown rapidly. Members wishing to be registered as a member of this Division of Instruments and Regulators should advise the Secretary of the A.S.M.E., 29 West 39th St., New York 18, N. Y.

President's Page

A Task Before Us

THE war is making changes fast in our pattern of working and living. Many of them will persist. Engineers, in industry and outside, are finding new responsibilities and new opportunities; and some things they have done in certain ways they will not be able to do in just the old ways again.

We are concerned about the part our Society, our profession, can and ought to take in meeting problems being raised by changed and changing conditions.

First and foremost, of course, how can we make our contribution still more effective toward winning the war? That must take precedence of the collateral problems which, nevertheless, we cannot ignore.

What are we ready to do in regard to the re-employment of engineers returning from war service or released from war industries?

What will we do toward the selection and training of potential engineers who have had some technical instruction and experience in war service and have developed engineering aspirations?

As war contracts are cut back or terminated and as many industries must release staffs they have assembled for war work, how can we help industries that must expand their production of civilian goods or that are planning new ventures get the best available men no longer needed in war work? That shifting process is already going on; it will gain momentum, we are told, month by month.

Can we help industry and our profession by using the best available methods to find out the real vocational aptitudes of candidates for engineering jobs? How also can we find out what kinds of persons for what kinds of jobs are really wanted by the industries we would serve?

Let's look at one or two specific aspects of these problems as related to our present activities.

Engineering societies have provided an employment service that has proved its usefulness under normal conditions. Now the engineering profession faces new conditions such as we have never before experienced. How far should our Society go in adapting this service to these conditions? The best available techniques are none too good.

Our Society has co-operated with other engineering societies and with our splendid engineering schools in every effort to raise the standards of engineering education. Although engineering education has been redirected and to some extent disrupted by the war, in one form or another technological and engineering training is being given to far more students than ever before. The training that the war services have provided has discovered many competent technicians who should have opportunity to complete their technical education when they are free to do so. How best can we co-operate with other agencies in solving this problem?

Probably our chief present responsibility, next to doing our utmost toward total victory in this war, is to assist our members, the members of the engineering profession generally, and the young men now preparing to enter the profession, to fit into the new industrial life that lies ahead.

This altogether is a big task. How should we undertake it? It has many complexities. They will vary according to local conditions. It is my belief that this is a very definite moral and professional responsibility for each member of this Society, and for each of its local sections, as well as for those who operate the personnel service of the engineering societies.

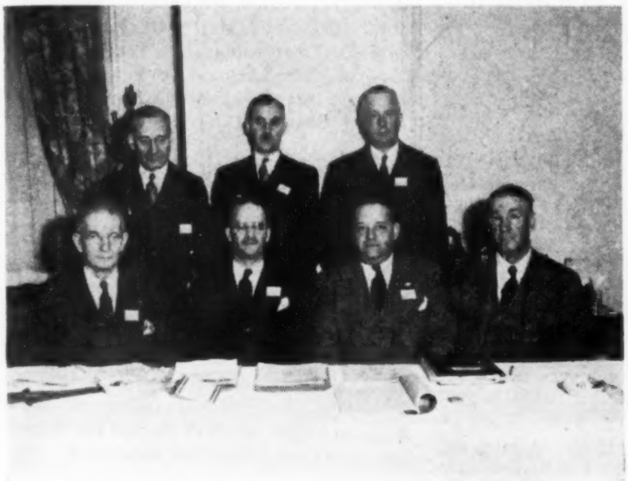
The Council and our committees welcome suggestions from our members generally. No individual and no group can be expected to find the right answers to these questions, nor can effective use be made of the right answers, if found, without full co-operation. In your own various activities and contacts, you can not only give thought to the problems but you can also locally go to work on them.

The problems are here now. Let us meet them before they reach their postwar dimensions.

(*Signed*) R. M. GATES, *President*, *A.S.M.E.*

Nominating Committee Urges Early Suggestions for 1945 A.S.M.E. Officers

THE 1944 A.S.M.E. Nominating Committee held its organization meeting during the Annual Meeting in New York on December 2, 1943. George J. Nicastro was elected chairman and John P. Magos was elected secretary.



SOME MEMBERS OF NOMINATING COMMITTEE FOR 1944
(*Seated, left to right:* F. O. Hoagland, Geo. J. Nicastro, chairman, J. P. Magos, secretary, and A. M. Ormond. *Standing, left to right:* H. R. Westcott, J. Stanley Morehouse, and E. V. David.)

The Nominating Committee has the very responsible duty of selecting qualified and competent leaders to guide the management and destiny of the Society.

Offices to Be Filled

The Constitution, By-Laws and Rules, Articles C-7, B-7, and R-7 govern the election of directors. Those to be nominated are the President for one year, three Vice-Presidents for two years, and three Managers for three years.

In general, the President is chosen from the past Vice-Presidents, the Vice-Presidents are chosen from the past Managers, and the Managers are chosen from the members who have been active in the Society and are familiar with its operation.

Any Member May Suggest a Candidate

Any member may suggest a candidate for office. A proposal form may be obtained from the Secretary of the Committee. The form lists some of the information which will be helpful to the Committee in giving proper consideration to the candidate. It is desirable to have the form filled out by the proposer (not the candidate). Some assurance of the candidate's willingness to serve should be secured before he is proposed. After the form is filled out, send it to the Secretary of the Nominating Committee, J. P. Magos, Crane Company, 836 S. Michigan Avenue, Chicago, Ill.

Do Not Delay—Act Now!

Members are urged to make suggestions for candidates to serve as A.S.M.E. Officers for 1945 as soon as possible so that the Committee may give full consideration to each proposed candidate. Please do not delay. Act now.

The 1944 A.S.M.E. Nominating Committee

GROUP I
Representative—Frank O. Hoagland, *Chairman*, Pratt & Whitney Co., Charter Oak Boulevard, West Hartford, Conn.
1st Alternate —H. R. Westcott, Westcott & Mapes, Inc., 139 Orange St., New Haven, Conn.
2nd Alternate —Prof. J. W. Zeller, Northeastern University, Boston, Mass.

II
Representative—George J. Nicastro, Combustion Engineering Co., 200 Madison Avenue, New York, 16, N. Y.
1st Alternate —E. V. David, Air Reduction Sales Co., 60 E. 42nd St., New York 16, N. Y.
2nd Alternate —A. Ehbrecht, Gries Reproducer Corp., 780 E. 133rd St., New York, N. Y.

III
Representative—J. Stanley Morehouse, Dean, School of Engineering, Villanova College, Villanova, Pa.
1st Alternate —Virgil M. Palmer, Eastman Kodak Co., 1669 Lake Avenue, Rochester, N. Y.
2nd Alternate —C. E. Harrington, University of Buffalo, Buffalo, N. Y.

IV
Representative—A. M. Ormond, Savannah Sugar Refining Co., Savannah, Georgia
1st Alternate —E. E. Williams, Duke Power Company, Charlotte, N. C.
2nd Alternate —J. Mack Tucker, University of Tennessee, Estabrook Hall, Knoxville, Tenn.

V
Representative—Darwin S. Brown, Cincinnati Gas & Electric Co., 4th & Main Sts., Cincinnati, Ohio
1st Alternate —S. M. Weckstein, Timken Roller Bearing Co., Canton, Ohio.
2nd Alternate —E. M. Sampson, Felber Biscuit Co., Grant Avenue & McCoy St., Columbus, Ohio

VI
Representative—J. P. Magos, *Secretary* Crane Company, 836 S. Michigan Avenue, Chicago, Ill.
1st Alternate —C. F. Moulton, Nebraska Power Co., 4th & Jones Sts., Omaha, Neb.
2nd Alternate —D. P. Morse, General Motors Corp., Speedway City, Indianapolis, Ind.

VII
Representative—W. H. Kassebohm, Production Engineering Co., 940 Dwight Way, Berkeley 2, Calif.
1st Alternate —Alf Hansen, General Electric Company, 235 Montgomery St., San Francisco, Calif.

VIII
Representative—H. L. Crain, Kansas City Power & Light Co., 115 Grand Avenue, Kansas City, Mo.
1st Alternate —Wm. T. Alliger, P. O. Box 2217, Houston, Texas
2nd Alternate —Henry M. Robinson, Dallas City Water Works, 112 City Hall, Dallas, Texas

Mr. Coes Thanks A.S.M.E. Members for Their Loyal Support

New York, December 24, 1943

TO THE MEMBERS:

Good friends, I have received so many congratulations by mail, by phone, and verbally for our efforts in the past year, that I came to the conclusion that the situation was somewhat out of focus. Despite this I am very grateful to you all for your generous approval and commendation.

However, when you congratulate me you are congratulating yourselves for the accomplishments in the past year. You had a good Council, and able hard-working Executive Committee, a loyal, competent, hard-working staff, and the committees generally performed well. Individual members of the Society when called upon for special services, or assignments, responded as they usually do.

It is this deep sense of loyalty to the Society, belief in its aims, and objectives, in its service to members, to government and society at large that raised the Society, in my opinion, to new high, but temporary, peaks of attainments, of accomplishments, and of prestige.

I was just coxswain of the winning crew. You attribute, my friends, too much to me and not enough to yourselves.

It is now our job to make this coming year, by united and co-operative efforts, even more eventful and successful.

My sincere regards and best wishes to all of you.

HAROLD V. COES
Past-President, A.S.M.E.

F. C. Houghton Honored

THE American Society of Heating and Ventilating Engineers has announced the award to Dr. Ferry C. Houghton, of the F. Paul Anderson Medal "for outstanding research over a long period of years in the fields of heating, ventilating, and air conditioning, resulting in distinct benefits to the public and the nation, for advancement of the knowledge of the psychological reactions of persons to their environments and for careful presentation of the technical data readily adaptable to general use in engineering."

Presentation of the medal will be made on Feb. 2, 1944, during the 50th annual meeting of the A.S.H.V.E.

Edison Medal Awarded to Vannevar Bush

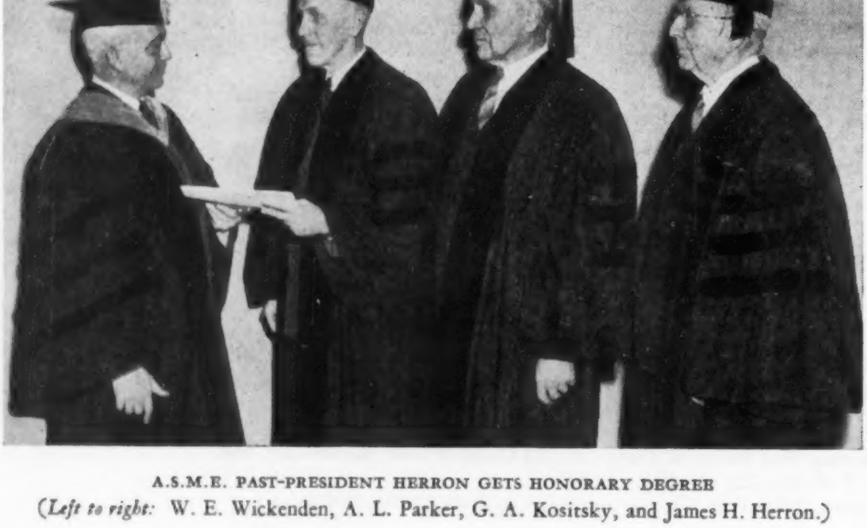
VANNEVAR BUSH, president of the Carnegie Institution of Washington and Director of the Office of Scientific Research and Development of the Office of Emergency Management, Washington, D. C., has been awarded the 1943 Edison Medal of the American Institute of Electrical Engineers.

The award goes to Doctor Bush "for his contribution to the advancement of electrical engineering, particularly through the development of new applications of mathematics to engineering problems, and for his eminent service to the Nation in guiding the war research program." The medal will be presented on January 26 at the A.I.E.E. winter meeting.

Doctor Bush received the Holley Medal at the 1943 Annual Meeting of The American Society of Mechanical Engineers.

James H. Herron Receives Honorary Degree

AT THE 60th Commencement Exercises of the Case School of Applied Science, Cleveland, Ohio, December 20, James H. Herron, past-president, A.S.M.E., received the honorary degree of doctor of engineering. Mr. Herron was presented for the degree by Prof. F. H. Vose, member A.S.M.E. The degree was conferred by Dr. W. E. Wickendem, member A.S.M.E., president, Case School of Applied Science who in conferring the degree, referred to Mr. Herron as "engineer of many distinctions, leader in professional activity both local and national, citizen in good works, and counselor of young engineers."



A.S.M.E. PAST-PRESIDENT HERRON GETS HONORARY DEGREE
(*Left to right:* W. E. Wickenden, A. L. Parker, G. A. Kositsky, and James H. Herron.)

Carl S. Marvel to Head American Chemical Society

CARL Shipp Marvel, professor of organic chemistry in the University of Illinois, has been elected president of the American Chemical Society for 1945. Dr. Marvel took office as president-elect on Jan. 1, 1944, when Dr. Thomas Midgley, Jr., vice-president of Ethyl Corporation, and internationally known for his discovery of tetraethyl lead, became president, succeeding Dr. Per K. Frolich, director of the Chemical Division, Esso Laboratories, Standard Oil Development Company, Elizabeth, N. J.

Thomas Chester Honored

THE Silver Medal of The Institution of Heating and Ventilating Engineers (London) h s been awarded to Thomas Chester, member A.S.M.E., for his paper "Drying by Heated Air," presented in 1939.

In announcing the award to Mr. Chester the acting secretary of the Institution stated that this medal "is the only one of this standard to be given for the whole of the war and immediate prewar years 1937–1942 inclusive."

To Help Textile Men in Armed Forces

AN invitation has been extended to members of the American armed forces at present in Great Britain who were formerly engaged in the textile industry to take advantage of the facilities which are available through The Textile Institute, Manchester, England.

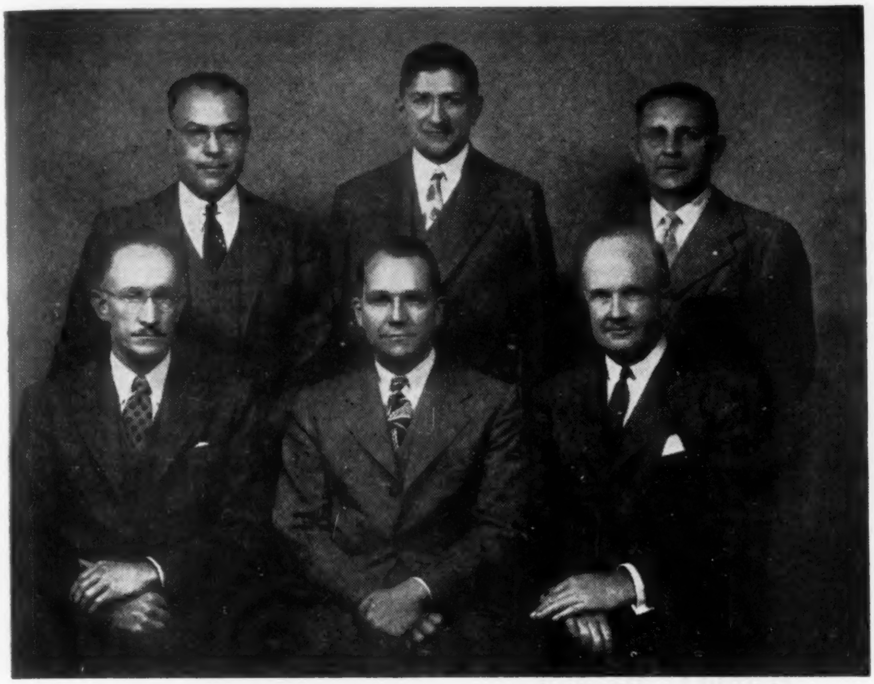
Several sections of the Institute arrange programs of meetings during the winter when textile lectures and discussions are held on matters of technical interest. There is also a library, which contains many trade and scientific journals in addition to standard works and reference books on textiles. Members of the armed forces who wish to take advantage of these facilities should communicate with the Acting General Secretary, The Textile Institute, 15 St. Mary's Parsonage, Manchester 3, England.

To Publish Instruments and Regulators Terminology

THE Terminology Committee of the Industrial Instruments and Regulators Division has prepared a list of 40 terms and definitions of importance in the field of automatic control. This list is to be published in the March issue of MECHANICAL ENGINEERING at which time comments and criticisms will be invited and reprints will be made available for those who may desire them.

The list represents the results of six years' work by the Terminology Committee which was initially sponsored by the Committee on Industrial Instruments and Regulators of the Process Industries Division out of which the I.I.R.D. was formed.

J. B. McMahon is acting as chairman of the Terminology Committee during the absence of chairman H. F. Moore.



1944 STANDING COMMITTEE ON LOCAL SECTIONS
(*Front row, left to right:* J. A. Keeth, S. R. Beitler, Oliver B. Lyman. *Back row, left to right:* A. R. Mumford, Ernest Hartford, assistant executive secretary, A.S.M.E., and S. D. Moxley.)

Among the Local Sections

Boston Section Hears About P-38 as a Fighter

At the Boston Section meeting at Northeastern University on December 8, 100 members and guests heard Lieut. Danny Kennedy, U.S.A., speak on "The P-38 as a Fighter Plane in Tunisia and Sicily." He gave a vivid account of his experiences on the Tunisian and Sicilian battle fronts flying the P-38 plane as both a fighter and a bomber. Lieutenant Kennedy was high in his praise of the plane. He gave his personal rating of the German flyers as very capable and having excellent planes. Two combat films were also shown by Lieutenant Koch of the First Corps Area.

Pipe Line "Big Inch" Subject at Columbus Section

On December 9 the Columbus Section met at Battelle Memorial Institute to hear the world's largest pipe line, popularly known as the "Big Inch," discussed by A. I. Richardson, manager of the Cincinnati District of the Allis-Chalmers Manufacturing Company. Mr. Richardson's talk, which was illustrated by lantern slides, covered some of the economics and engineering problems involved in the design, construction, and operation of this pipe line.

Detroit Juniors Hear Dean Freund on "Getting Ahead"

On November 23 the Detroit Junior Group held its first meeting of the 1943–1944 season in the Rackham Educational Memorial. The meeting was preceded by showing of an Army film entitled "War on Wheels."

Dean C. J. Freund, of the Committee on Economic Status of the Engineer, presented the problem faced by that committee. One of the factors in which Dean Freund is interested and on which he asked discussion is the rate of advancement.

The Junior Group members present voted to sponsor a questionnaire survey to try to arrive at a measure of proper progress for a young engineer, and to measure the degree to which individuals are satisfied with their personal progress.

A later meeting will be devoted to "off the record beefs" about the policies of individual employers, such as failure to distinguish between professionally trained engineers and draftsmen.

N. W. Dougherty Speaks at East Tennessee Section

The East Tennessee Section met at Knoxville, Tenn., with the A.I.E.E. group on December 22 to hear N. W. Dougherty, dean of engineering, University of Tennessee, talk on the subject of "Do Machines Civilize?" Eight members and 30 visitors were present.

Dean Kimball Addresses Ithaca Section

The Ithaca Section and 36 members of other societies met on December 15 at the Langwell Hotel, Elmira, N. Y., to hear Dean Emeritus Dexter S. Kimball speak on the subject of "The Future of Engineering and Engineering Education." Dean Kimball gave a historical review of engineering education and outlined the relation of junior colleges to engineering colleges. An interesting question-and-answer discussion followed the dean's address.

Fundamentals of Lubrication at Milwaukee Section

On December 8 the Milwaukee Section met at Plankinton Hotel, to hear P. A. White, sales engineer, Wadham's Division, Socony Vacuum Oil Company, Inc., discuss the subject of lubrication. Mr. White suggested a division of oil applications into three classes, i.e., bearings, gears, and pistons. Mention was made of the fact that generally light oils are used for low loadings, low temperatures, or high speeds, while high loading, high temperatures, or low speeds require heavier oils. A moving picture telling the experimental lubrication story was shown.

Following the picture, Mr. White told of the various distinguishing characteristics of oils. From these characteristics, he pointed out, the severity of service may be determined as well as the suitability of a given oil.

Prof. L. S. Marks Describes Gas Turbines at New Haven

On November 16 the New Haven section met to hear Prof. Lionel S. Marks speak on the subject of "Gas Turbines." Professor Marks introduced the subject by telling of Stodola's work and his influence on those who studied under him. Mechanical and thermodynamic features of the gas turbine were described, as well as the development work being done in Switzerland.

Peninsula Section May Form War Production Committee

A meeting was held on November 17 by the Peninsula Section at Grand Rapids, Mich., for the purpose of organizing a War Production Committee for Western Michigan. Paul T. Onderdonk of New York explained the purpose and structure of the Committee and the results attained by other similar committees throughout the country.

Joint Meeting Held at Pennsylvania State College

A joint meeting of the Central Pennsylvania Section and the Centre County Engineers Society was held on December 7, at the Pennsylvania State College Campus to hear Dr. A. W. Gauger speak on "Automatic Comfort Heating." The development of a small domestic stoker to burn caking bituminous coals was traced. Preoxidation of the coal before it reaches the combustion zone was reported responsible for the successful operation. Time-elapse motion pictures of the combustion process were shown.

I. A. Hunt on Dimensional Control at Providence

Providence Section met on December 7, to hear Irving A. Hunt of the Federal Products

Corporation speak on "Modern Practice in Dimensional Control." Mr. Hunt illustrated his talk with motion pictures in color with sound.

Two Speakers Discuss Oil for War at Rochester Section

The Rochester Section met on December 9 at the Sagamore Hotel, to hear S. Kent Wood of Socony Vacuum Oil Company and Arnold H. Barben, mechanical engineer, Goulds Pumps, Inc., speak on "Oil for War." The latter discussed the subject from the standpoint of pumps, types used, operating features, pressures, sizes, and locations in pipe lines. Mr. Wood gave general details of methods used in the construction and operation of pipe lines. A movie of the "Big Inch" pipe was shown.

Modern Submarines Described at San Francisco Meeting

The San Francisco Section met on December 2 to hear Lieut. D. V. Daniels, U.S.N. (retired), speak on "Submarines and Their Activities." He described the general construction and arrangement of modern submarines. A movie also was shown of life on a submarine under war conditions.

This Section met again on December 16, to hear E. S. Prud'homme speak on General Electric Company's "Variable-Speed Drives," based on electronic control.

An attendance of 93 was chalked up at the January 6, 1944, meeting of this Section when J. C. Fletcher of the J. C. Fletcher Company, San Francisco, talked on "Dial Indicators." Mr. Fletcher showed two sound films in connection with his talk and then explained in more detail the application and operation of dial gages for measurement of screw threads. Lively and interesting discussion followed the talk.

A. Hollander Speaks at Southern California

On December 10 a joint meeting of the Hydraulic Division of the Southern California Section of the A.S.M.E. and the class in pumps and hydraulic machinery at the University of Southern California was held to hear A. Hollander, consulting engineer of the Byron-Jackson Company. Approximately 100 engineers were present.

Washington, D. C., Section Holds Two Meetings

Members of the Washington, D. C., Section met on October 14 to hear A. S. Flemming, U. S. Civil Service Commission, speak on the subject of "Federal Government's Manpower Problems." Mr. Flemming outlined the setup of the Civil Service Commission for recruiting employees to fill positions in all branches of the Government, and stressed the fact that the same manpower regulations apply to government as to private industry.

On November 11 this Section met again to hear Dr. J. T. Rettaliata, chief research engineer, Allis-Chalmers Manufacturing Company, Milwaukee 1, Wis., speak on the subject of "Gas Turbines."

Waterbury Section Hears Harold C. Manning

The Waterbury Section met on November 18 at the Hotel Elton, Waterbury, to hear Harold C. Manning talk on "The Patent System and Curious Inventions." Mr. Manning gave an outline of the history and importance of the patent system, licenses, infringements, patent pools, curious patents, attacks on the system, the Kilgore "Science Mobilization" bill, and a report of National Patents Planning Commission. About 50 slides were shown.

Society Officers Address Western Massachusetts Meeting

The annual joint dinner meeting of the Engineering Society of Western Massachusetts and the Western Massachusetts Section, A.S.M.E., was held at the Highland Hotel in Springfield on December 21. Ernest Hartford, executive assistant secretary, A.S.M.E., and Harold V. Coes, past-president, A.S.M.E., New York, were the guest speakers. Mr. Hartford paid tribute to the Engineering Society of Western Massachusetts for its unified plan in bringing all the engineering profession into one group, while Mr. Coes talked on "What Management Means to the Engineer."

Electronics Discussed at West Virginia Section

The West Virginia Section of the A.S.M.E. met at Charleston, West Va., on November 22, at which meeting C. T. Pierce, Middle Atlantic District engineering and service manager of the Westinghouse Electric & Manufacturing Company, Philadelphia, Pa., spoke on "Electronics at Work." About 130 members and guests attended the meeting.

Mr. Pierce explained the theory and fundamentals of "electronics" and many of its various applications, as well as the advantages of "electronic" devices over other types.

A sound moving picture on the subject, which was produced by the Westinghouse Company, illustrated the many applications which these devices have in the industrial world at the present time.

Western Washington Section Gets Ship Machinery Details

The Western Washington Section met November 30 at the Gowman Hotel, Seattle, Wash., to hear J. A. Davies of the Westinghouse Electric & Manufacturing Company describe features of the design of marine turbines and reduction-gear units now being used in Maritime Commission ships.

Antifriction Bearings at Worcester

On December 7 the Worcester Section met at the Worcester Polytechnic Institute, to hear Frank U. Naughton, Jr., of Hyatt Bearings Division of General Motors Corporation, speak on "Antifriction Bearings, Application, Design, Manufacture, and Maintenance." Handbooks on the subject were distributed.

AMERICA'S SLUGGING POWER ASSEMBLED AT THE ABERDEEN PROVING GROUND, MD., PERFORMS BEFORE MEMBERS OF THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

(During a recent visit to the world's greatest proving ground at Aberdeen, mechanical engineers were treated to a side-line view of Uncle Sam's fighting might as the principal American weapons were demonstrated and proof-fired before interested onlookers.)

MEMBERS OF A.S.M.E. STUDENT BRANCH AT CLARKSON MAKE INSPECTION TRIP TO RACQUETTE RIVER PAPER COMPANY MILL

With the Student Branches

Reports Results of Student Guidance in Metropolitan Area

BECAUSE of the demands of the war, the New York Engineers Committee on Student Guidance, in the fall of 1942, took stock of its resources and the changed conditions confronting the schools, according to William H. Larkin, chairman of the committee, in a report to the executive committee of the A.S.M.E. Metropolitan Section.

It was decided to go ahead with the committee's program, and a meeting was held on Dec. 3, 1942, at Stevens Castle, as guests of President H. N. Davis and with N. H. Memory, a charter member of the committee, the host at luncheon. Samuel P. Horton outlined the degree of correlation that appears to exist between aptitude tests made on the undergraduate and his vocation ten years after graduation. Thirty members of the committee and seven representatives of various New York City high schools were present.

In spite of war conditions lively interest in the work of the committee was found in the schools. On April 1, 1943, three thousand students crowded the auditorium of the Brooklyn Technical High School to hear J. W. Barker, special assistant to the Secretary of the Navy, outline the Navy program.

During the year 22 guidance meetings were held at 22 schools in the metropolitan area with a total attendance, excluding general assemblies, of 1923 students.

The committee has found a large increase in the number of girls who are attending its meetings.

Branch Meetings

The Industrial Development Engineer at Clarkson

On November 30 the CLARKSON BRANCH held a meeting at which Dr. Falls gave a talk entitled, "The Industrial Development Engineer." He stated that there were basically two types of engineers—those in actual manufacturing processes, and those in work preliminary to production, although he confined his talk to the latter. These engineers, he said, could specialize in research, development, or design. In mass production, little opportunity is offered for research, but in the job shop, where no two products are the same, research and development are important, he added. He then listed the work of the development engineer under five headings, the three major ones being development of new products, improvement of old ones, and simplification of existing ones. The others, he said, deal with technical information through the sales department and technical problems of production engineers.

On December 8 the Branch made an inspection trip to the Racquette River Paper Company mill at Unionville, N. Y. The group, which consisted of 30 members, had its picture taken prior to making the trip by automobile.

A joint meeting with the student chemical engineers was held on December 15 at which the growth of the Chrysler Corporation was shown in a movie, "Years of Progress."

CALIFORNIA TECH BRANCH held its monthly business meeting on December 2, at which time plans for the year were discussed. Nomination of officers also was held. Twelve members were present.

The COLORADO STATE BRANCH on December 6 held a joint meeting with the A.S.C.E. and A.I.E.E. groups. The meeting was opened by showing of the Allegheny Ludlum motion picture "Stainless Steel." New officers then were elected. They are Clarence Edward Vincent, chairman; H. Merle Jessup, vice-chairman; Frank Harvey Pless, secretary; Lewis Shook, Jr., treasurer; H. Merle Jessup, program chairman; and R. D. Barmington, honorary chairman.

Motion Picture of Autogiro at Columbia

The COLUMBIA BRANCH met on November 26. A sound motion picture showing the autogiro and explaining briefly the theory of its operation was presented. The effects of different bodies on the air stream, of turbulence and streamlining, taken in a smoke chamber were also shown. A discussion followed the movies, centering mainly around postwar developments in automotive and aeronautical engineering.

This Branch met again on December 17 at which John Most was elected secretary, and Howard Bodner, treasurer. At this meeting a movie supplied by the Wright Aeronautical Corporation demonstrated some of the principles of its Cyclone engine.

Cooper Union Plans 1944 Program

Newly elected officers of the COOPER UNION BRANCH conducted their first meeting on November 17. The officers include Arthur Zigas, president; Robert Klint, vice-president, and Gustave Rothmaler, treasurer. The meeting was opened by showing of the Allis-Chalmers sound movie on turbines, "The Magic of Steam." The primary purpose of the meeting, however, was to select committees and to obtain ideas for the year's program. The matters discussed included a freshman reception to be held early in 1944; presentation of student papers, and an annual dinner at Easter.

On December 8 this Branch met again, at which time two motion pictures on internal-combustion engines were featured. They were General Motors' "The Power Within," and Ford's, "Making a V-8 Engine."

Ability to Write Engineering Reports of Value

The DREXEL BRANCH held a meeting on November 11 at which the guest speaker was Marv Hamberg, a graduate of Drexel in mechanical engineering, class of 1941, and now associated with the Atlantic Refining Company. He discussed from his experience what engineering graduates may expect in the industrial world and stated that all of the required engineering courses have a valuable and necessary place in their training. He also stressed the value of being able to write an engineering report. The Atlantic Refining Company sound film, "Building a Bomber," showing the sequence of assembly of the Martin B26 bomber, was presented.

The ILLINOIS BRANCH held a special meeting on December 1 for the purpose of acquainting the new with the "old" members. On December 6, this Branch met to hear Chief Machinist Mate H. S. Clair of the Naval Diesel School stationed at the University give an interesting account of his 27 years of marine service. The seventh meeting of this Branch was held on December 15, at which time Professor Fahnestock of the mechanical-engineering department spoke on "Education and Research in Aviation."

W. G. Christy Stresses Need for Conserving Fuel at Lafayette

LAFAYETTE BRANCH met on October 28 to see two interesting films on aviation, entitled, "Flying Fortress B-17," and "Fairchild Trainer PT-19." The former showed the manufacture and production of the plane, while the Fairchild film showed the construction of the plane and its flying ability as a training plane.

This Branch met again on November 23, at which meeting William G. Christy, manager, A.S.M.E., and Smoke Abatement Engineer, Hudson County, N. J., spoke on "Fuel, a Bottleneck in Our War Effort." Mr. Christy indicated the ways in which fuel is wasted and outlined methods for conserving this vital necessity of war production.

At the conclusion of Mr. Christy's address, officers for the coming year were elected as follows: Richard Klemmer, chairman; Charles du Pont, vice-chairman, and Melvin Schiff, secretary-treasurer.

The MICHIGAN MINING AND TECH BRANCH met on November 15 to hear a letter read which was received from the National Society, encouraging joint sessions among the active societies on the campus. It was agreed by this Society that joint sessions would prove most satisfactory if outside guest speakers were obtained. A brief but interesting talk was then given by student member Ralph Laumer on the subject "Radar." Another meeting was held on November 30, to hear Mr. Latimer, an engineer from Houghton County Electric Light Company speak on "Power Plants." He discussed the various equipment used, their auxiliaries, and safety devices used in connection with each. This Branch met again on December 14, to see a film, "Light Airplane Construction," produced by the Piper Aircraft Company.

The fall dinner meeting of the MINNESOTA BRANCH was held on November 30. After the dinner Professor Rowley, head of the mechanical-engineering department, reported on the progress of plans for the new mechanical-aeronautical-engineering building, and on the significance of membership in professional engineering societies. On December 3, officers were elected for the ensuing year as follows: Harry Foehringer, president; Daniel Greenwald, vice-president; Neil Griebenow, secretary; Verne Peck, treasurer.

On November 20, the MISSOURI BRANCH sponsored an inspection trip to Centralia, Mo., visiting the Chance Manufacturing Company plant, and the Eastern Pan Handle Company gas piping station. The trip was made by 31 students and 3 members of the mechanical-engineering faculty. This Branch met again on December 8, to elect new officers: George Tretiak, president; James Howell Peebles, vice-president; Fred Lebensart, secretary; Robert Toal, treasurer. Following the election a Westinghouse motion picture on "The New Jobs for Refrigeration," was shown.

The first fall meeting of the MONTANA BRANCH was held on November 10 at which plans were developed to increase the membership from the Army engineering student group. The results of the membership campaign were reviewed on November 24, by Ralph Challender, Jr., president of the Branch, who reported that nearly every student mechanical engineer had been contacted, including the Army engineers. At the meeting a committee also was appointed to bolster the drive for members from the Army engineers, and another committee to select the most suitable motion pictures to be shown at future meetings. Prof. Gerald Pessman gave an interesting report on pilot instruction.

The NEW HAMPSHIRE BRANCH met on November 23 to hear Professor Grant discuss an article, "The Engineer as Planner," written by Ralph E. Flanders. In the course of his discussion Mr. Grant outlined his agreements and disagreements with Mr. Flanders' ideas. An open forum was then held. Mr. E. P. Nye, the faculty adviser, brought up many questions as to the part to be played by engineers in present and postwar problems. No attempt was made to suggest a solution to the problems, but the young engineer's role in the present and future world was stressed.

New Mexico Branch Meets With A.I.E.E.

On December 1 the NEW MEXICO A.&M. BRANCH held its first meeting of the new term to elect officers from among the soldier-civilian student members. They are Pfc. Jack Howard, president; Pfc. Malcolm McGregro, vice-president, and Pfc. George Randle, secretary-treasurer. A paper was presented by Pfc. George Randle on the history, advantages, uses, and future possibilities of fiberglas. This Branch on December 22 held a joint meeting with the Student Branch of the A.I.E.E. Fifty-five members were present to see the film, "The Alaskan Highway," and to hear Jack Burleson present an interesting paper, "The Electron Microscope."

The NEW YORK UNIVERSITY EVENING BRANCH held a meeting on October 27. At this meeting Alfred Johnson was elected chairman of the Branch, succeeding Robert Jensen, who expected to be inducted into the Navy. Robert Wood was elected vice-chairman, succeeding Ace Woods, who had recently been killed in an accident. Suggestion was made that the Branch get together with the Junior Members of the A.S.M.E., which suggestion will be discussed at future meetings.

The NEWARK BRANCH on December 6 held a joint society meeting at the Newark College of Engineering. The meeting was sponsored by the mechanical-engineering students, and members of the Civil, Electrical, and Chemical Engineering Branches participated. The speaker of the evening was R. H. Wilson of the General Electric Company, whose topic was "Welding." This Branch held another joint meeting on December 20, under the auspices of the Student Branch of the Chemical Engineers. The speaker of the evening was Professor Tully of the chemical-engineering department, who spoke on explosives and their applications.

New Officers at North Dakota

New officers were elected at a meeting of the NORTH DAKOTA STATE BRANCH on December 3. They are Samuel Hess, president; Donald Schaelzel, vice-president; Norman Mickleson, secretary-treasurer. Three members and 26 visitors enjoyed the Wright Aeronautical Corporation film, "Cyclone Combustion."

The first meeting of the NORTHEASTERN BRANCH was held on December 16 to elect new officers. They are Joseph C. Profita, chairman; John J. Smialek, vice-chairman; James F. Connors, treasurer; Serafin J. Krukonis, secretary; Sidney F. Austin, program committee; and James N. Russo, social committee.

On November 16 the NOTRE DAME BRANCH met with Honorary Chairman C. R. Egry delivering the address of welcome to incoming members and V-12 trainees who had transferred to Notre Dame. The following newly elected officers were installed at the meeting: Casimir Rejent, chairman; Matthew Bajorek, vice-chairman; James Gormeley, secretary; and Gerald Putnam, treasurer. At the meeting it was also suggested to form a bowling league to be composed of the various engineering societies on the campus. At the conclusion of the meeting the members attended a lecture and movie on "Vinyl Polymers and Their Application in Engineering." Twenty members were present.

Latin-American Conditions Shown in Films at Purdue

On November 24 the PURDUE BRANCH met to see two films depicting phases of conditions in Latin America. "Our Neighbors Down the Road" described a trip on the Pan-American highway from Venezuela to Cape Horn and north again to Rio de Janeiro. Along the route could be seen not only the scenic beauty, but also some of the details of construction of the highway. The picture "Venezuela Moves Ahead" depicted South American country with its agriculture, its broad plains, and imposing mountains. Among the matters of interest were the great oil deposits and their development, mostly through financing by American concerns; the work being carried on by American engineers, utilizing modern equipment.

This Branch met again on December 1 at which time R. E. Orton, chief engineer of the Acme Steel Company, spoke on "Theory in Commercial Practice." From his wide range of practical experience, Mr. Orton presented a vivid picture of the conflict between the theoretical idealism of the young engineer on one side and the long-time rule-of-thumb understanding of the "practical man," by whom he is surrounded in industry. In order to get ahead, he stated, full co-operation is needed between these two groups. One important factor, he said, in the engineer's part of the adaptation is appreciation of the limitation of his theory. A stimulating discussion closed the meeting.

The Branch met on December 7 to hear Professor Boelter speak on "Heat Transfer in Tubes," taking into consideration the convection flow. Fifty members were present.

On December 22 the Branch convened for a Christmas Party meeting. As a bit of preliminary business, officers were elected to replace those who left the University at the end of December. The officers were Hans Wormser, chairman, succeeding Bob Gallatin; Micha Schocken, Horace Davidon, and Harold Grube, vice-chairman, succeeding Hans Wormser, Jack Swants, and Frederick Hohenstein, and Wayne Price, new secretary-treasurer. At the meeting of the Pi Tau Sigma Freshman Award to the outstanding sophomore entering the mechanical-engineering school was presented to Robert Gray. The award was a Mechanical Engineering Handbook.

Ordnance Experts Explain Their Work at Rensselaer

The RENSSELAER BRANCH met on November 23 to hold its monthly meeting. The program consisted of a lecture on the "Background of Ordnance and the Manufacture of Cannon,"

by Captains Lake and Burnham of the Watervliet Arsenal. Captain Lake outlined the duties of any Army or Navy man in ordnance work and spoke on the different divisions of production, namely, the cannon or gun barrel, the gun carriage, the firing mechanism, and the accessory equipment. Captain Burnham told of the variety of cannon made at the arsenal, ranging from 35 mm to 16 in. He classified cannon as falling into two main divisions: those using fixed ammunition which range from 37 to 90 mm, and those using loose ammunition which go up as high as 16 in. Captain Burnham then traced the manufacture of a cannon from forging to the finished product and mentioned many production improvements that have been made in the last 2 years. A question period followed the two talks.

Reorganization Meeting Held at Rhode Island Branch

The RHODE ISLAND STATE BRANCH on October 22 held a reorganization meeting, the purpose of which was to activate the Society to its prewar status. New officers also were elected at the meeting, as follows: Normand D. Andrews, chairman; Leroy Erickson, vice-chairman; O. Robert Pansa, secretary, and Kenneth N. Astill, treasurer.

RICE BRANCH met on November 17 to hear Dr. Barlow speak on the "Development of Aircraft." Dr. Barlow discussed the transition from wartime to commercial cargo aircraft. He also presented slides of various types of planes and a motion picture of the stages of production of a trainer-type airplane. Mr. Taylor, another speaker, discussed the subject of "Consolidating Air Transportation and Its Problems." This Branch met again on November 24, at which time a contemplated field trip on November 29, to the Deepwater Power Plant of the Houston Power & Light Corp., was abandoned, and another date discussed. The regular meeting of the Branch was set for December 15, with Professor Degler of the University of Texas as principal speaker. Two other field trips were planned—one to Sheffield Steel and one to Emsco, both in Houston. Announcement also was made of the meeting in April of the Student Branch of the A.S.M.E. at Austin, Tex.

Professor Tyrrell Addresses Rutgers

Prof. C. C. Tyrrell was guest speaker at a meeting on December 7 of the RUTGERS BRANCH. His topic was "Engineering Contacts and Their Importance," which was well received by the members. At a meeting on December 28 the following officers were elected: William Stalker, chairman; Robert Goldberger, vice-chairman; Robert Godfrey, secretary, and Thomas Peterson, treasurer.

Tennessee Nominates Officers for Spring Quarter

The TENNESSEE BRANCH held a meeting on December 2 at which Professor Thomas extended an invitation to Army specialized training students to attend future A.S.M.E. meetings. Two films were shown entitled "Jap Zero," and "Singing Wheels."

At the January 13 meeting of the Branch the new chairman for the winter quarter, James H. Hodges opened the discussion onthe election of new officers. It was decided to hold the election by written ballot for the spring quarter and the following members of the Branch were nominated: For chairman, Jack Hart, Melvin Sturm, and Stanley Huddleston; for vice-chairman, Eric Eckberg, Millard Myers; for secretary-treasurer, Mary Porter Fain, Oliver Dale, and Gene Holthofer. Miss Kathleen Neeley is the second woman to apply for membership in the Branch.

Professor Thomas then showed a collection of colored slides that he had made at other universities and of parks and interesting spots throughout the country, which were very much enjoyed by those in attendance at the meeting.

Technique of Powder Metallurgy Described at Toronto

The TORONTO BRANCH met on November 30 to hear O. W. Ellis, of the Ontario Research Foundation, speak on the subject of "Powder Metallurgy."

This Branch met again on December 13, 1943, to go on a field trip through the Victory aircraft plant at Malton, 25 miles out of Toronto. Forty-seven members and 11 visitors enjoyed the trip.

As described by Mr. Ellis, powder metallurgy is not to be regarded as a panacea, bound eventually to replace other methods. On one occasion when 200 parts were submitted by various engineers as probable cases for powder metallurgy, only 12 of them were found to be most economically made by that method.

Another general impression which Mr. Ellis wished to dispel was that this process was the result of recent invention. Actually gold Babylonian coins have been found which were made by heating compacts made from powdered metal. This represents the method now employed. A combination of properly screened powders (up to 400 mesh) is forced together under pressure up to 100 tons per sq in. to bring individual particles into close contact, after which the compact so formed is heated or "sintered" to run the particles together.

After pressure and before sintering, the metal would appear under the microscope to contain numerous voids among the particles, but after the latter process the metal appears the same as that produced by other methods, with hardness, strength, and ductility just as great. (Some sheets produced in this way will bend through 180 degrees.) Some compacts can even be machined and then heat-treated for hardness. Any metal may be used in this way, Mr. Ellis said, except mercury.

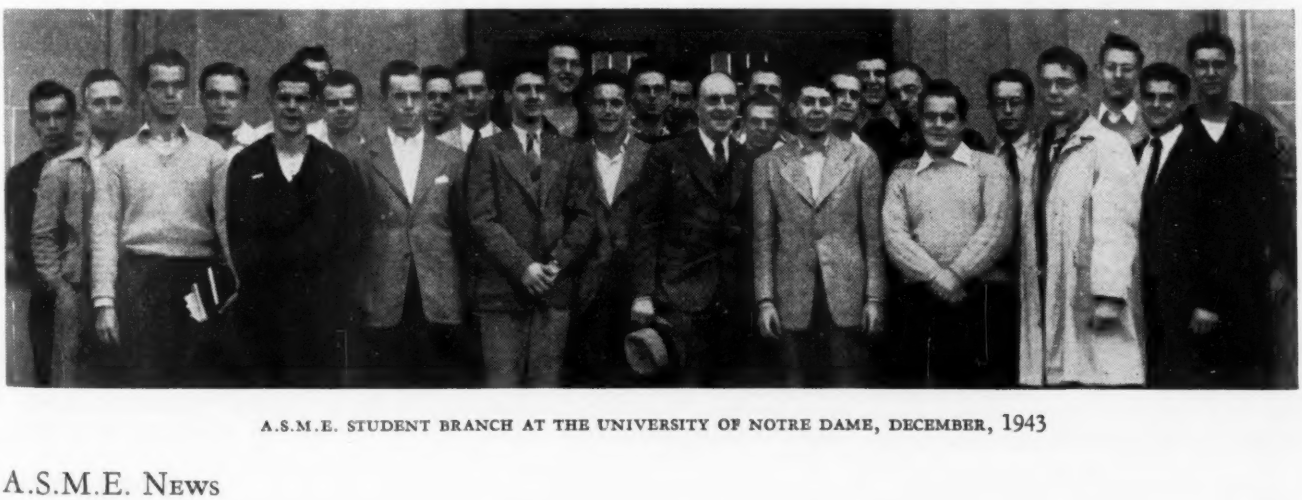
In the design of powder-metallurgy parts, Mr. Ellis said, all conditions such as mechanical, chemical, and electrical properties, desired shrinkage of the metal on sintering, and size and tolerance of the part, must first be known or the process may prove uneconomical. Even the rate at which the die will wear must be considered as it will affect the economy of a design.

Tufts Branch Shown Working Models of Locomotives

The first meeting of the combined engineering societies of the TUFTS BRANCH was held on December 2 with a majority of the members of the chemical, civil, electrical, and mechanical engineering societies present. It was announced that combined meetings would be held for the duration of the war, with the intent of having bigger and better meetings.

The speaker of the evening was Lester D. Friend, president of the New England Live Steamers Association. Mr. Friend had on exhibit one of his models built to a scale of $^3/_4$ in. = 1 ft, which required 3000 hr to build, or approximately 3 years at 8 hr a day. Also on display was Mr. Friend's latest venture, 1300 hr old, a 4-6-6-4 freight-type locomotive, with all the superstructure yet to be built. Mr. Friend also gave an interesting talk on the history of the Association which started in England about 1890. He showed some interesting moving pictures taken at the Association's track at Danvers, Mass., and at other tracks throughout the United States.

At a meeting of the VIRGINIA BRANCH on November 16, 31 members and 14 visitors enjoyed a sound film, "The Construction of a Light Airplane," which was sponsored by The Piper Company. On November 20, this Branch met again, at which time 25 members and 10 guests viewed a film entitled, "Norton Abrasives." After the picture, there was a



A.S.M.E. STUDENT BRANCH AT THE UNIVERSITY OF NOTRE DAME, DECEMBER, 1943

discussion period in which various aspects of the film were discussed with the professors present. On December 8, officers for the coming year were elected including Preston Pope Lee, president; Lewis L. Green, vice-president; James R. Thrower, Jr., secretary; Andrew B. Bolton, Jr., treasurer; Frederick T. Morse, honorary chairman.

Continental Divide Tunnel Film at Virginia Polytechnic

At a joint meeting of the VIRGINIA POLYTECHNIC BRANCH with the agricultural students and civil engineers on November 29, two motion pictures were shown. The first was a Navy film, "Layout and Lofting," dealing with the steps in the design of an airplane from its beginning to production. A second film, of special interest to all present, was a color sound movie, supplied by Ingersoll-Rand Company, showing the driving of a 10-ft power and irrigation tunnel through 13 miles of the Continental Divide. Prof. C. H. Long, honorary chairman, presided at the meeting in the absence of E. D. Kilgore, the student chairman.

This Branch met again on December 6, to hold a smoker and to elect new officers. The officers are D. W. St. Clair, chairman; T. E. Hall, Jr., vice-chairman; Y. C. Yang, corresponding secretary; G. R. Pucci, recording secretary, and H. G. Powers, treasurer. Prof. W. J. Barber was elected the new honorary chairman.

West Virginia Holds Four Meetings in November

The WEST VIRGINIA BRANCH held four meetings during November. At the first meeting on November 8, speakers and technical subjects were: W. McCoy, "Magnesium Makes the Grade;" T. Olsen, "The Automobile of the Future;" and J. Wargacki, "Dehydration of Foods." At the November 15 meeting, speakers and subjects were, B. Judy, "Concrete Ships;" and J. Rowe, "Your Future." The November 22 meeting included W. Combs, "Our American Bombsight;" R. Fisher, "Rate Making in the Electrical Industry;" J. Murray, "Electronics, a New Science in a New World;" and T. Olsen, "Gas Turbines." The last meeting was held on November 29, and at this time the following speakers were heard: R. Fisher, "Weapon Maintenance in Actual Combat;" F. Mumma, "Electro-Tinning and Its New Position;" F. Pritchard, "Aircraft Heaters;" and J. Rowe, "Motion Study."

1944 A.S.M.E. Committee Personnel List Sent on Request

MEMBERS of The American Society of Mechanical Engineers who wish to receive a copy of the 1944 issue of the Society Records containing committee personnel are requested to fill out and mail the accompanying form, or order by letter, addressed to the Secretary, A.S.M.E., 29 West 39th Street, New York 18, N. Y.

This issue, which will be published in February, will form a part of the Society Records Section of the Transactions as bound for library use.

A.S.M.E.
29 West 39th St.
New York 18, N. Y.

Please send me a copy of the February, 1944, issue of the Society Records.

NAME..............................

ADDRESS..............................

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Preventing Welding and Cutting Fires

TO instruct users of welding and cutting equipment in reducing potential fire losses, the International Acetylene Association has prepared at 16-page pocket-size booklet entitled "Preventing Welding and Cutting Fires." This booklet, written in easy-to-understand style, contains brief, clear discussions of the chief causes of fires and practical common-sense measures for preventing them. Copies of this booklet may be obtained in reasonable quantities without charge from the International Acetylene Association, 30 East 42nd Street, New York 17, N. Y.

A.S.A. Issues Standards Tests

THE American Standards Association announces the publication of its new list of standards. More than 600 standards are listed, of which 64 have been approved or revised since the last price list was printed (April, 1943). The standards cover specifications for materials, methods of tests, dimensions, definitions of technical terms, procedures, etc. The new list includes 95 safety standards.

Requests for a copy of the new list should be addressed to the American Standards Association, 29 West 39th St., New York 18, N. Y.

Association of Corrosion Engineers

AN organization known as the Mid-Continent Cathodic Protection Association was formed in 1938 for the purpose of exchanging information regarding developments in the field of mitigation or prevention, by electrical means, of corrosion to pipe lines and other metallic structures. Other purposes were the promotion of co-operative action between companies or organizations and the development of standard procedures and methods.

Since 1940, the members of this Association have been meeting and carrying on their activities as the Cathodic Section of the Petroleum Industry Electrical Association.

This group is now forming a new organization to be known as the National Association of Corrosion Engineers. All persons engaged in the work of corrosion control or mitigation on underground metallic structures are invited to apply for membership. Inquiries should be directed to: O. C. Mudd, acting secretary-treasurer, Shell Pipe Line Corporation, Box 2648, Houston 1, Texas; or to: R. A. Brannon, acting president, Humble Pipe Line Company, Drawer 2220, Houston 1, Texas.

Index to 1943 Volume of Mechanical Engineering

AS Section 2 of the January, 1944, issue of the Transactions of the A.S.M.E., separate indexes to the Transactions and to MECHANICAL ENGINEERING for 1943 were mailed to the A.S.M.E. membership.

An additional copy of the index to MECHANICAL ENGINEERING may be secured from A.S.M.E. Headquarters, 29 West 39th Street, New York 18, N. Y., by sending ten cents for handling charges.

A.S.A Approves Standard Letter Symbols for Gear Engineering

THE American Standards Association has recently approved the American Standard Letter Symbols for Gear Engineering (B6.5–1943), which it is hoped will establish a uniform practice in mathematical notation for equations and formulas dealing with toothed gearing. The symbols included in this standard cover those used in connection with design, application, manufacture, inspection, and new methods and problems in this field. The purpose of the work is to facilitate a clear understanding of mathematical work in published articles, papers, and books and to eliminate possibilities of confusion. It is not intended that these letter symbols be used on working drawings or in manufacturing records.

The standard was developed under the technical leadership of The American Society of Mechanical Engineers and the American Gear Manufacturers' Association and by a subcommittee of the A.S.A. Committee on the Standardization of Gears. The subcommittee is headed by D. T. Hamilton, of the Fellows Gear Shaper Co.

It may be obtained from the American Standards Association, 29 West 39th Street, New York 18, N. Y.

A.S.M.E. Local Sections

Coming Meetings

Baltimore. February 28. Engineers' Club of Baltimore at 8:15 p.m. The subject will be of a general aircraft nature. Alexander Kartveli, chief engineer, Republic Aircraft, Farmingdale, L. I., will be the speaker.

Cleveland. February 10. Cleveland Engineering Society, 2136 East 19th St., Cleveland, Ohio. Dinner at 6:30 p.m.; meeting at 8:00 p.m. Subject: "Developments in Navigation," by John J. Nassau, professor of astronomy, Case School of Applied Science, Cleveland, Ohio. This will include the story of navigation from the time of Columbus up to the present time.

East Tennessee. February 3. Terrin Hall, University of Tennessee, Knoxville, Tenn., at 7:45 p.m. Subject: "Precision Measurements in Industry," by a representative of Savage

Tool Company through its St. Louis representative.

Metropolitan. February 25. Building Trades Employers' Association, 2 Park Ave., New York, N. Y., at 6:30 p.m. This will be a social evening with a buffet supper, with some of the latest movie releases of the Army and Navy for entertainment. President R. M. Gates will say a few words and there will be ample time to greet old acquaintances and make new ones. Tickets at $1.00 each may be obtained from J. H. Krooss, chairman, Metropolitan Section Dinner Committee, A.S.M.E., 29 West 39th St., New York 18, N. Y.

New Haven. February 15. Mason Laboratory, Yale University at 8:00 p.m. Subject: "Postwar Adjustment and Labor Problems," by D. H. Davenport, U. S. Dept. of labor.

Providence. March 7. Providence Engineering Society, 195 Angell St., Providence, R. I. at 8:00 p.m. Subject: "The Working of Magnesium," by Otis E. Grant, Production Control Magnesium Division, The Dow Chemical Co., Detroit, Mich.

Waterbury. February 24. Colonial Room, Hotel Elton, Waterbury, Conn. Dinner at 6:45 p.m. Meeting at 8:00 p.m. Subject: "Modern Miracles in Glass," by C. J. Phillips of Corning Glass Company, Corning, N.Y.

Western Massachusetts. February 15. Hotel Highland, Springfield, Mass., at 6:30 p.m. Subject: "Electronics In Industry," by Carl J. Madson, electronics engineer, Westinghouse Electric and Manufacturing Company. This will be a joint meeting with the Engineering Society of Western Massachusetts and the Springfield Section of the A.I.E.E.

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., which is under the joint management of the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to members and is operated on a co-operative, nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrants whose notices are placed in these columns. All replies should be addressed to the key numbers indicated and mailed to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available to members of the co-operating societies at a subscription of $3 per quarter or $10 per annum, payable in advance.

New York 8 West 40th St. **Boston, Mass.** 4 Park St. **Chicago** 211 West Wacker Drive **Detroit** 100 Farnsworth Ave. **San Francisco** 57 Post Street

MEN AVAILABLE[1]

MECHANICAL ENGINEER, M.S. degree, age 48, with extensive additional training in internal-combustion-engine design and correlated subjects. Licensed New York professional engineer. Twenty-four years' marine, municipal, and industrial Diesel power-plant design, construction, and operation experience. Writes and speaks fluently four foreign languages. Formerly engaged as project engineer, supervising engineer, and consulting engineer. At present not engaged by war industry. Seek permanent connection. Me-828.

MECHANICAL ENGINEER, 45. Production and engineering experience in both mass production and heavy industry as factory manager, plant engineer, chief engineer, some sales. Believes capable of works manager or similar. Me-829.

MECHANICAL ENGINEER, designer, 42 years old. Fifteen years design, checking, and layout of high-pressure vessels, piping, pipe flanges and covers, and outside pressure vessels, (API-ASME Code and Metric Code), also miscellaneous apparatus for heavy chemical industry. Me-830.

MECHANICAL ENGINEER, 41, executive, M.I.T. graduate, twenty years' experience in design and development of electrolytic and metallurgical processes. Now chief engineer of steel-fabricating plant. Desires permanent position. Me-831.

[1] All men listed hold some form of A.S.M.E membership.

POSITIONS AVAILABLE

ENGINEERS. (*a*) Industrial engineer with considerable experience in production planning on small precision metal manufacture. Will be in complete charge of planning for company employing several thousand employees. $8000–$10,000 year. (*b*) Company also needs assistant to the above. $6000 a year. Eastern Pennsylvania W-3139.

INDUSTRIAL ENGINEER, young, for work with old-established industrial management firm. Some traveling. $5000–$6000 year. Headquarters, New York, N.Y. W-3140.

MECHANICAL ENGINEERS. (*a*) Man to design transmissions in connection with aeronautical installations. (*b*) Also engineer to design aeronautical-engine mountings. Prefer man who has worked close to mechanics doing actual installation. Salary open. New York, N.Y. W-3146.

TOOL ENGINEER, preferably graduate mechanical with at least 8 to 10 years' experience in tool design. Will be required to redesign equipment for improvement in products. Prefer man with some experience in small-firearms work. Definitely postwar opportunity. $5000–$6500 year. Connecticut. W-3148.

ENGINEERS. (*a*) Tool engineer. Should have minimum of 5 years' experience in tool and die practice and must be capable of passing on tools necessary for different processes and be able to get them into production. Will be in charge of tool design and stores with department of about 30. $5500–$6000 year. (*b*) Project engineers. Must be capable of supervising the design, setup, planning, layout, and following through of production of entire job. Company doing mostly machine job shop work. $5500–$6000 year. Connecticut. W-3150.

PRODUCTION ENGINEER, preferably with experience with automatic packaging of consumer goods. Must be able to set up production plans and schedules, estimate time and costs, requisition purchases, set up controls and standard operation procedures. About $6000 year. Permanent. New York State. W-3163.

DESIGNERS, mechanical, to work on redesign of magneto and fuel-injection systems, both aircraft and automotive. Salary open. New York, N. Y. W-3164.

INSTRUMENT OR DEVELOPMENT ENGINEERS, graduates, experienced in design, development, or project engineering, preferably in line of instruments or quantity manufacturing of small devices. Will be in charge of full range of development program. $5000–$6000 year. Pennsylvania. W-3166.

ENGINEERS. (*a*) Chief engineer to take charge of design section of company manufacturing large-sized rotary presses, paper-handling machinery, etc. $6000–$7500 a year. (*b*) Machine designers with experience on large work as above. $3600–$4000 year. New England. W-3173.

PRODUCTION ENGINEER, 28–38. Must be graduate mechanical or industrial engineer with considerable experience with modern production practice, manufacturing methods, and process improvement. Work will cover plants doing light metal stamping, spring turning, woodworking, textile and paint manufacture. Therefore a varied experience is desirable. Will be in entire charge of all production in company's several plants. Permanent. Salary open. Headquarters, Ohio. W-3175.

SHOP SUPERINTENDENT, mechanical engineer, to take charge of plant employing about 120 people on precision work for aircraft industry, i.e., valves, hydraulic equipment for landing gears, and the like. Will lay out and plan the work, estimate time and costs, etc. $6500–$7500 year. Location, New York, N. Y. W-3178.

DIRECTOR OF RESEARCH, either electrical or mechanical, graduate preferred, with some experience in electronic operated devices. $8000–$10,000 year. Northern New Jersey. W-3184.

PLANT ENGINEER, mechanical, preferably with rayon experience, but not necessary. Must have successful record of broad experience as plant or assistant plant engineer. Will have full charge of all plant operations covering building maintenance, plant maintenance, and purchasing of all materials and equipment. Permanent. Apply by letter giving complete details. Rhode Island. W-3193B.

PRODUCTION CONTROL ENGINEER. Must have previous experience in complete charge of production control for metal manufacture and have background and knowledge of heat-treatment of steel. $10,000 year. East. W-3196.

Plant Superintendent or Assistant Plant Superintendent to take charge and operate processing plant of pitch products. Mechanical engineer with any asphalt-plant experience will be acceptable. Permanent. $4000–$5000 year. New York, N. Y. W-3213.

Graduate Engineer, preferably mechanical or electrical who has had considerable experience in construction of power plants to co-ordinate work of subcontractors in construction of large industrial powerhouse. Should be qualified through experience to handle this type of work. $7200 year. South. W-3214.

Mechanical Engineer for design and development work, mainly in connection with electromechanical devices. Must be qualified to solve new problems and work without supervision. About $5200 year. New York, N. Y. W-3222.

Railroad Service Engineer, 35–45, preferably graduate mechanical engineer with several years' practical experience in motive-power or mechanics department of railroad; or in service work with manufacturer or railroad motive-power equipment. Will service petroleum products to railroads on the Atlantic seaboard. Apply by letter giving complete information. Headquarters, New York, N. Y. W-3230.

Engineers. (*a*) Factory manager to take complete charge of small plant, including production flow layout, assembly for manufacture of small electronic parts. $8000–$10,000 year. (*b*) Process engineer, preferably with some electronic background, to be in charge of writing up of specification sheets on production planning and in general simplification of production methods. $5000 a year. New York metropolitan area. W-3233.

Candidates for Membership and Transfer in the A.S.M.E.

THE application of each of the candidates listed below is to be voted on after February 25, 1944, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

Re = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

Member, Associate, or Junior

Acheson, Louis K., North Canton, Ohio
Amsler, Rolf, Milwaukee, Wis.
Arents, Chester A., Corvallis, Oregon
Aurien, Ray G., Evanston, Ill.
Beck, Harold, Brooklyn, N. Y.
Bessom, Richard H., Swampscott, Mass.
Booij, M. L., New York, N. Y.
Bourgeois, Claude, Drummondville, Que., Canada
Boynton, E. R., Schenectady, N. Y.
Branin, Francis S., North Plainfield, N. J.
Bubar, Willard C., New York, N. Y.
Burrows, L. Manley, North Quincy, Mass.
Butler, R. A., Oil City, Pa.
Canvasser, Marvin A. (Air Cadet), Detroit, Mich.
Carson, Harold V., Coatesville, Pa.
Catlin, Harold M., St. Davids, Pa.
Chapman, Edmund E., Oak Park, Ill. (Rt)
Charlton, E. J., Coatesville, Pa.
Cobb, Leland D., Forestville, Conn.
Crawford, Ernest A., Hoboken, N. J.
Cuddeback, Alva E., Bayside, N. Y. (Rt & T)
Davis, Benjamin H., Ridgewood, N. J.
De Bell, George W., Stamford, Conn.
de Roco, J. L., Boulder City, Nevada
de Stoppelaar, L. P. (Lieut. Comdr.), New York, N. Y.
Donkersley, Albert B., Providence, R. I.
Drace, Chas. A., Belmont, Calif.
Drew, C. H., Huntington, Ind.
Eyres, S. A., Syracuse, N. Y.
Finch, Rogers B. (Capt.), Jeffersonville, Ind.
Finnegan, Thos., Buffalo, N. Y.
Fuchs, Henry O., Detroit, Mich.
Gimmel, Robt. S., Louisville, Ky.
Gray, Wm. E., Mt. Rainier, Md. (Rt)
Hendrix, Houston W., Philadelphia, Pa.
Johnson, Sigurd T., Salt Lake City, Utah
Libman, Frank H., Westminster, Md.
McCort, J. E., Cleveland, Ohio
Mills, David L., Maywood, Ill.
Moeller, H. G., Chicago, Ill.
Moore, Coleman B., Philadelphia, Pa.
Parcels, C. F., Louisville, Ky.
Redfield, John A., Monroe Center, Conn.
Rodgers, Walter A., Baldwin, N. Y.
Schmidt, Alfred O., Milwaukee, Wis.
Slater, R. E. O., Chicago, Ill.
Steurer, George E., Dayton, Ohio
Stovall, B. L. (Lieut.), Houston, Texas
Taylor, G. A., East Orange, N. J.
Tetzel, Fred B., Louisville, Ky.
Thieblemont, Andre H., New York, N. Y.
Vermillion, Verdon, Independence, Mo.
Walmsley, S. E., Gravesend, Kent, England
Weick, Fred E., College Park, Md.
Wells, J. Arthur (Lieut.), New York, N. Y.
White, S. A., New York, N. Y.
Wilcox, Edw. M., Cincinnati, Ohio (Rt & T)
Wilder, Forrest G., Winthrop, Mass.
Wright, S. C., Jr., New York, N. Y.

CHANGE OF GRADING

Transfers to Fellow

Dalton, Wm., Schenectady, N. Y.
Ernst, Hans, Cincinnati, Ohio

Transfers to Member

Broberg, Orrin R., Burbank, Calif.
Cole, Gilmoure N., Manchester, Conn.
Davidson, Sidney, New York, N. Y.
Dunbar, A. W., High Point, N. C.
Frank, Robt. M., Bloomfield, N. J.
Greer, Chas. H., Clarksville, Tenn.
Grinter, Dean L. E., Chicago, Ill.
Hall, Stanley R., North Hollywood, Calif.
Hamilton, Earl B., Dayton, Ohio
Herman, K. R., Detroit, Mich.
Hirshfeld, Egon, Brooklyn, N. Y.
Hoban, Chas. O., Glencoe, Ill. (Rt)
Jenkins, Robt. W. (Maj.), Camp Beale, Calif.
Jones, Frank A., Bristol, Tenn.
Jones, Spencer A., New York, N. Y. (Rt)
Killinger, C. E., Marietta, Ga. (Rt & T)
King, Wm. J., Lynn, Mass.
Knight, L. P., Birmingham, Ala.
Kyhl, Louis C., Chicago, Ill. (Rt)
Lamson, C. P., Rushville, Ind.
Lesser, W. H., Scranton, Pa. (Rt)
Loewy, Raymond, Sands Point, N. Y.
McCollum, Paul E., Santa Monica, Calif.
McGowan, Joe J., Los Angeles, Calif.
McGregor, H. G., Grosse Pointe Woods, Mich
Meister, L. (Lieut.), Bradley Beach, N. J.
Miller, Edgar H., Cranford, N. J.
Morton, Stanley, Vancouver, B. C.
Newnham, Donald E., Rochester, N. Y.
Oberst, Donald A. (Major), La Carne, Ohio
Opsahl, E., Niagara Falls, Canada
Peterson, Vernon R., Zanesville, Ohio
Pierce, Edgar M., Johnson City, Tenn.
Pitman, Richard W., Philadelphia, Pa.
Prather, Jas. C., Atlanta, Ga.
Prostrednik, E. J., Philadelphia, Pa. (Rt & T)
Rakovsky, A., Montreal, Que., Canada
Rardon, Norman C., Needham, Mass.
Robinson, Eric, Altrincham, Cheshire, England
Sinclair, Edw. L., Philadelphia, Pa.
von Herrmann, C. F., Jr. (Lieut.), Birmingham, Ala.

Necrology

THE deaths of the following members have recently been reported to headquarters:

Antisell, Frank L., May 25, 1943
Barnum, George S., November 29, 1943
Belcher, Warren J., December 1, 1943
Belches, Edmund B., November 28, 1943*
Bentley, Edward S., June 29, 1943*
Dillingham, Charles K., Jr., June 7, 1943*
Eckhard, William K., November 23, 1943
Guillo, Harry P., December 3, 1943
Miller, Frank P., December 11, 1943
Pierle, Henry C., January 14, 1943
Van Atta, Ralph R., April 7, 1943
Veeder, Curtis H., December 27, 1943

* Died in line of duty.

A.S.M.E. Transactions for January, 1944

THE January, 1944, issue of the Transactions of the A.S.M.E. contains two sections:

Section One:

Requirements for Relief of Overpressure in Vessels Exposed to Fire, by J. J. Duggan, C. H. Gilmour, and P. F. Fisher

Wood-Cloth and Wood-Paper Laminates, by John Delmonte

Superchargers for Aircraft Engines, by R. G. Standerwick and W. J. King

Test and Predicted Oil-Cooler Performance, by A. L. London and J. I. Brewster

Section Two:

Society Records including indexes to publications